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*Editor*

ROY WALDO MINER

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# SEDIMENTARY BASIN DEVELOPMENT AND ITS BEARING ON OIL OCCURRENCE*†

*By* L. G. WEEKS‡

The incidence of oil occurrence in sedimentary basins is closely related to two groups of basic factors. The first of these concerns the genetic type, manner of growth, and the architecture (the physical framework and the bottom form or configuration) of the basins at the time of deposition. The second concerns the conditions of sedimentation and environment within the basin and on the basin bottom during and immediately following deposition. The second of these groups of factors is closely related to the first, and largely dependent on it.

The first part of this paper, therefore, deals with the physical development of basins. The second part deals with some of the conditions of sedimentation and environment, within the basin of deposition itself, that have a bearing on oil occurrence.

The framework of the crust of the earth is essentially comprised of (a) relatively stable regions and (b) linear mobile belts (FIGURE 1). The latter consist of geosynclines of deposition and, usually, bordering geanticlinal welts (FIGURE 2).

The continents, even to including the central cores or shields, have grown by addition of concentrically developed mobile belts that have ultimately become stabilized. As a result, the paleogeography of each successive major diastrophic-sedimentation cycle is, in its broader aspects, radically different from those preceding.

The lengthy geosynclines of the mobile belts do not consist of uniformly continuous troughs. They are comprised of a succession of deposition sinks, roughly ovate in shape and separated, often in an *en echelon* manner, by saddles (FIGURE 3).

Practically all of the world's oil is accumulated in pools within or flanking deposition sinks. By far the greater number and usually the best developed of these occur along the mobile belts.

Basins of the broad stable regions produce relatively little of the world's oil and some are largely barren of commercial oil. The same applies to the broad stable parts of even the most prolific of basins (FIGURE 4). The total basin area in the world of this type greatly exceeds the total area within and adjacent to the mobile belt basins of the world outside of the present mountains.

The strain results of stresses, which gave us the deposition basins of the past and the structure basins of today, are widely different in the mobile belts from those of the stable regions.

In many, probably most, basins, subsidence is essentially a gravity sag phenomenon (FIGURE 5). In this respect, basins generally, even those of the belts that ultimately become highly mobile, began their existence and renewed their subsidences by downfaulting. These faults were minor to microscopic, producing simple basinal sags, or they were abrupt, producing graben or half-graben (FIGURE 6).

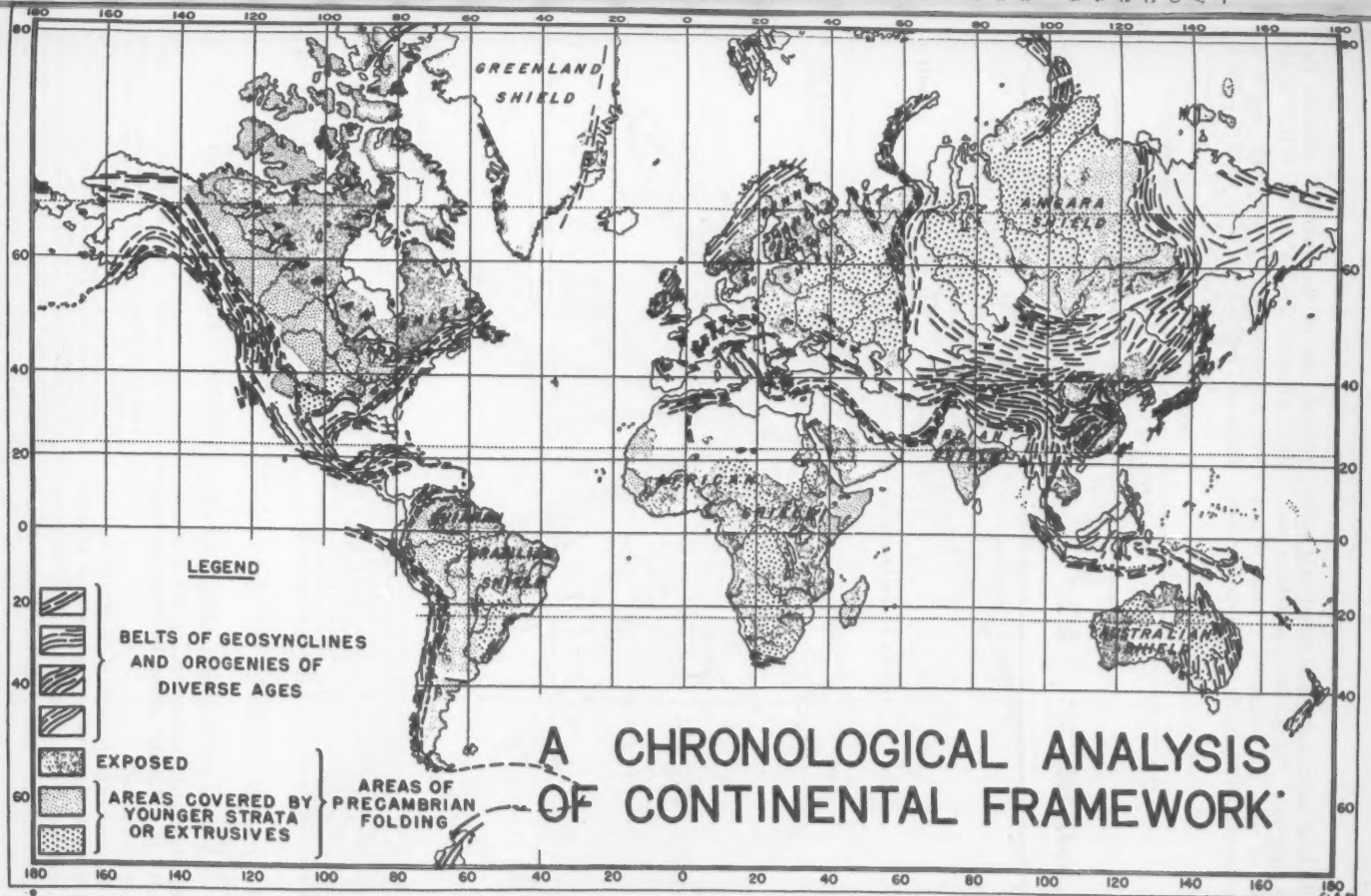
In the stable regions the basins did not generally evolve beyond the simple original basin stage of graben, half-graben or more truly synclinal sags. As the belts of mobility are approached in space, however, or as the basins of the mobile belts themselves (which also began as graben, half-graben or more truly synclinal sags) evolve with time to more advanced stages of mobility, the master border faults evolve into high-angle upthrusts, and the basin form, including the frontal folds, becomes more and more asymmetric (FIGURE 7). What takes place is essentially this. As the geanticlinal block rises, it spreads or is thrust tangentially forward. As the geosyncline subsides, there is lateral migration in the subcrust toward the base of the rising geanticlinal welt. The result is essentially a rotation in vertical section. Finally, in later stages of the diastrophic-sedimentation cycle (such as represented by the Appalachians, the Alps and other highly mobile belts), the growing geanticlinal border welt crowds forward, with low-angle overthrusting, toward the basin and foreland beyond, incorporating much of the sediments already deposited in the geosyncline (FIGURE 8).

A more comprehensive version of this paper is published in the November, 1952, Bulletin of the American Association of Petroleum Geologists.

* This paper, illustrated with lantern slides, was presented at a meeting of the Section on April 6, 1953.

† Grateful acknowledgment is extended to the management and exploration division of the Standard Oil Company (N. J.) under whose auspices and with whose encouragement this paper was presented.

‡ Chief Research Geologist, Standard Oil Company (N. J.).




*Modified after Umbgrove, J.H.F.,- THE PULSE OF THE EARTH. Martinus Nijhoff, Pub, The Hague, Netherlands, 1946

FIGURE 1.

In the latter paper, a simple classification of basins was presented. The classification includes essentially all types and conditions of basins or geosynclines of both the mobile belt and stable regions.

The types and relationships were analyzed and illustrated.

Some of the more important conditions of sedimentation and environment in the deposition basin that directly control oil occurrence may now be analyzed.

Evidence from the study of oil occurrence shows that the evolution of oil occurred early after the deposition of the sediments and their contained organic matter. This evolution, in the main, is probably one of the diagenetic processes that affect sediments between the time of their deposition and lithification. This early period of diagenesis, in which the oil is formed, is one of

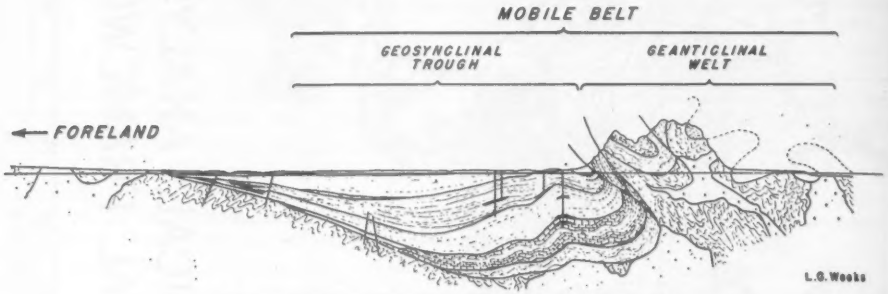



FIGURE 2. Diagrammatic cross section of an asymmetric mobile belt.

DISTRIBUTION OF DEPOSITION BASIN SINKS ALONG THE MOBILE BELTS OF THE WESTERN HEMISPHERE
(Incomplete and Diagrammatic)
L.G.Weeks

FIGURE 3. This map shows that all lengthy mobile belt geosynclines of the world consist of a series of deposition sinks, closely to widely separated by saddles, and are not uniformly continuous troughs. Likewise each mountain chain consists of a series of individual range segments, often separated *en echelon* by saddles, and is not a uniform continuous range. Nearly all of the world's oil is accumulated around deposition sinks, mostly developed along mobile belts, especially in the case of the more permanent sinks.

FIGURE 4.

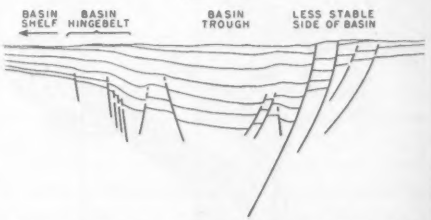
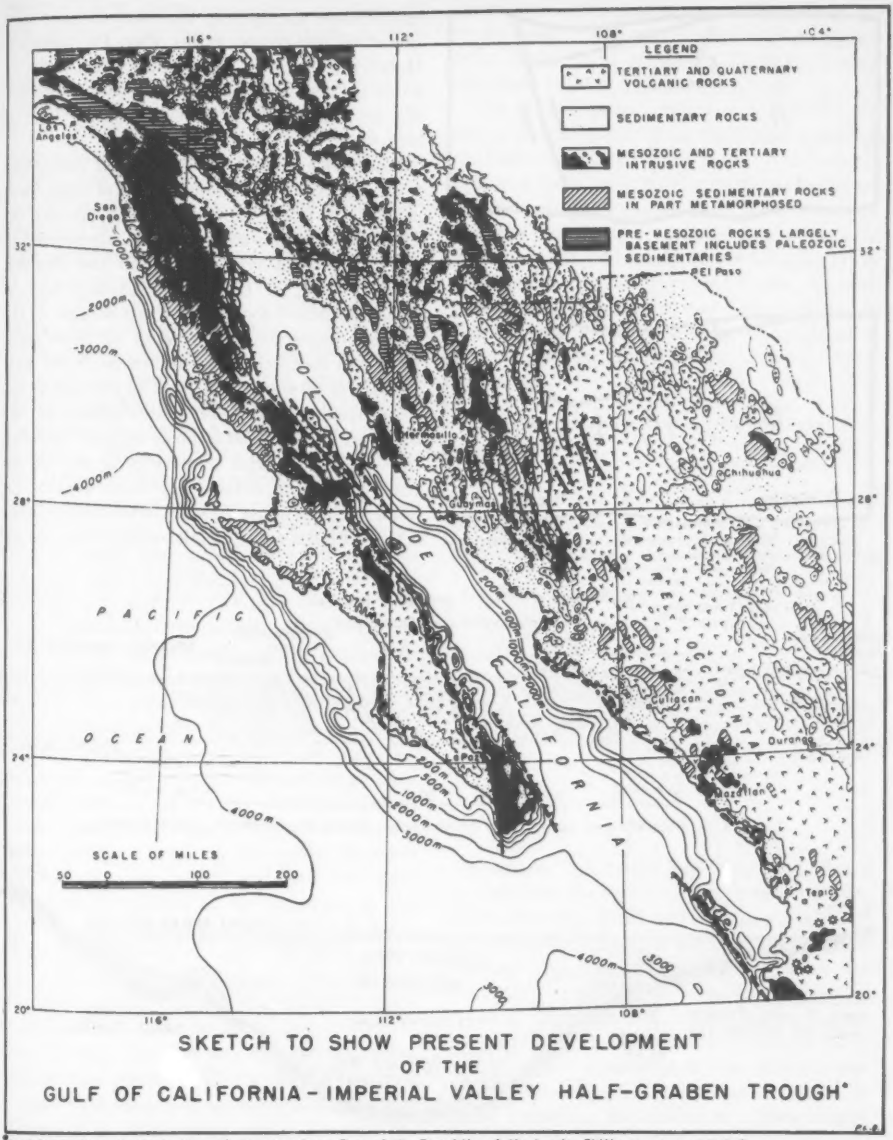



FIGURE 5. Diagram to illustrate a common form of basin subsidence resulting from the removal of support in the subcrust. Part of the adjustment to subsidence may occur along numerous lesser faults not shown in the diagram. Some are microscopic in size. Most of the faults in the diagram are shown as dying out upward in the soft sediments. This is generally true. Many more of these faults than we appreciate and countless lesser fractures, however, occur at the surface. These can be traced by careful inspection in the field.




*Modified after Geologic Map of the Northern Part of the Republic of Mexico by Philip B. King, U.S.G.S.

FIGURE 6.

physical, chemical, biochemical, and mineralogic instability. It is, therefore, a period of maximum change before stability is again established in balance with the radically new environment in the lithified sediments. As that stability becomes established, the changes correspondingly cease.

The incidence of oil occurrence varies roughly both in space and in time with the degree of

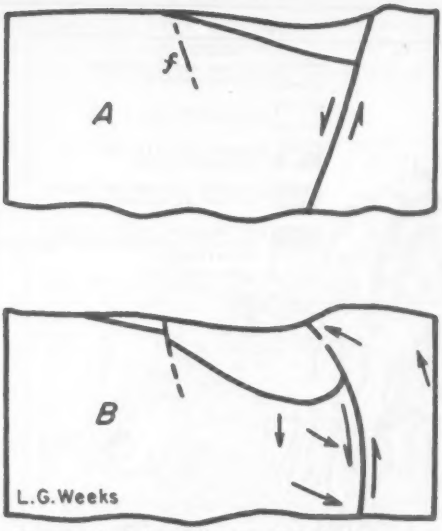



FIGURE 7. Simple sketch of two stages in the development of a mobile asymmetric basin which began as a half-graben.

rectly below the bottom that has directly controlled oil occurrence, rather than the mobility. Mobility has merely served, most frequently, to set up the deposition basin form needed to provide the environmental conditions necessary for oil occurrence.

World-wide analysis has shown oil occurrence to be highest in and around sinks of deposition, particularly where these were silled (FIGURE 9). There is, in other words, complete dependence of oil occurrence on environment and the resulting facies. These, in turn, are controlled by the bottom form and configuration of the basin at the time of deposition. As a result of these facts, which are convincingly confirmed by world wide analyses of oil occurrence, fully 80 per cent of the commercially recoverable hydrocarbons in the world are accumulated in pools that are scattered through belts or areas that comprise only 20 per cent of the total sedimentary basin area of the world. This is not surprising. The same situation is true with respect to metals, or any other natural

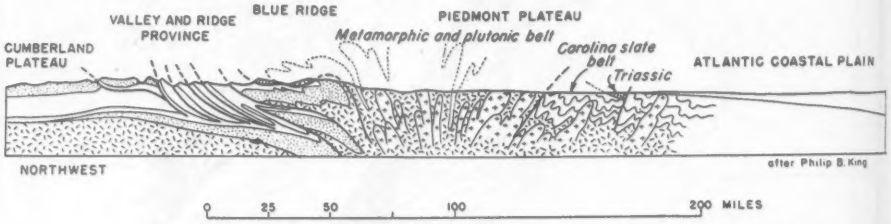



FIGURE 8. Diagrammatic cross section across the Appalachian System from Kentucky to South Carolina.

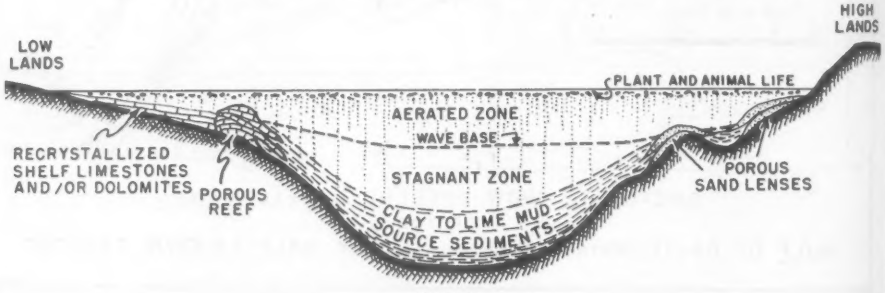



FIGURE 9.
SILLED OR RESTRICTED DEPOSITION BASIN
Illustrates the general relation of the aerated and stagnant zones to effective wave base, and a characteristic distribution, basinwise, of the resulting sediment facies. Vertical scale exaggerated. (After L. G. Weeks.)

mobility. It is important to understand, however, that it is the environment within the basin, on the basin bottom, and in the sediments diphenomenon the occurrence of which is controlled by environment.

Among the various determinants of environ-

ment, which in themselves control the type and distribution of the resulting lithofacies and biofacies, the following are briefly noted: the effective wave or current base; the oxidation-reduction potential or $E_h$; the hydrogen-ion concentration or pH; the temperature; the salinity; the light concentration; the biota or organic life itself, etc. Environment determines the basinwise distribution of the clastic, the chemical and biochemical facies, and the corresponding biofacies. Environment determines where organic life may thrive, where organic matter may be preserved for burial in the sediments, and where it must be largely destroyed regardless of quantities.

It is now necessary to look briefly at several of the more important factors and conditions of sedimentation and environment that influence or characterize the resulting facies in the basin of deposition. With regard to the carbonates, the main factor controlling deposition is the hydrogen-ion concentration, which is conventionally, though indirectly, expressed as the pH of the environment. There are many other factors that favor or inhibit carbonate deposition, but they do so by their influence on the pH.

Wide differences in the composition and character of the original sediments and their diagenetic products depend on the oxidation-reduction potential or $E_h$. One illustration concerning carbonate sediments may be cited here. In the aerated environment of positive O/R potential, the organic matter is exothermically reconverted through processes of aerobic decomposition to carbon dioxide and water. The carbon dioxide-bearing solutions permeate the newly deposited limestone and take calcium carbonate into solution. This is believed to be the origin of the vug to pin point porosity found only in such environment–facies belts or areas. With the cessation of decomposition, and dissipation of the carbon dioxide, there is extensive recrystallization and crystal build-up. The vugs and fractures that form widely during diagenesis are then lined with the newly formed crystals. Where the environment balance is right, diagenetic recrystallization involves dolomitization. World-wide studies convincingly demonstrate these environment–facies relationships and their correspondence, in turn, with the basin form and architecture.

While petroleum is a normal constituent of sedimentary rocks, commercial accumulations cannot, as a rule, occur except where both source and reservoir facies co-exist in proper relationship, one to the other. The two broad facies groups are quite distinct and separate. Normally, neither can result in oil accumulation by itself.

One of the readiest means of recognizing the environmental nature of the deposition is through the fauna or biofacies (FIGURE 10). The biofacies near and above wave base in restricted basins are predominantly benthonic; that is, they consist of forms that live as scavengers on an aerated bottom. On progressively deeper bottoms, below effective wave base in restricted basins, the complexion of the biofacies may very rapidly, in places almost suddenly, change to one that is dominated by remains from the plankton or surface waters.

**CLASSIFICATION AND DISTRIBUTION OF MARINE LIFE**
**NORMAL OPEN SEA**

**PLANKTON** – SURFACE ZONE OF SUNLIGHT AND PHOTOSYNTHESIS

MINUTE PLANT AND ANIMAL LIFE
CONSTITUTES BULK OF ALL LIFE IN THE SEAS

PHYTOPLANKTON Diatoms, peridineans and other flagellates comprise most of the phytoplankton.

ZOOPLANKTON Copepods and other kinds of crustacea make up the bulk of the zooplankton.
Planktonic Foraminifera: *Globigerina, Globigerinella, Globigerinoides, Orbulina, Pulvinulina*, etc.
Radiolaria
Bacteria

**NEKTON** – FREE SWIMMING ORGANISMS

Fishes of many kinds
Ammonites and other cephalopods
Bacteria

**BENTHOS** – BOTTOM LIVING ANIMALS ("BOTTOM SCAVENGERS")

Chalk formers, ammonites, and other types of benthonic Foraminifera
Pelecypods, gastropods, brachiopods
Ammonites and other cephalopods
Bacteria

FIGURE 10

Nonsource (commonly reservoir) environment and facies are characterized by high basin position, *i.e.*, on the basin flanks and bottom highs, where the bottom lies near or above sill depth and relatively near effective wave base. The environment is aerobic and of positive oxidation-reduction potential. Deposition is relatively slow, bottom living fauna may be abundant, and preservation of organic matter is excluded by its complete exothermic decomposition. Diagenesis results in drastic changes in the sediments. These include recrystallization of carbonate sediments and dolomitization.

Possible source (usually nonreservoir) environment and facies are characterized by a relatively low basin position, well below sill depth and effective wave base. The environment is anerobic and of negative oxidation-reduction potential.

Deposition is relatively rapid, bottom fauna is largely excluded due to toxic environment, and the preservation of organic matter is possible. Diagenetic processes give distinctly different results from those of the aerated environs. In this respect, the colors are darker and duller, the original finer textures are widely maintained, primary cherts may be abundant, minor to important parts of the original organic character may be retained, and recrystallization of limestones and dolomitization is largely absent.

It is in the aerated surface zone of sunlight that the life in the seas and the energy that is in petroleum had their ultimate origins. Here, through the processes of photosynthesis, and with the energy of the sun's rays, carbon dioxide and water are endothermically built into the plant life (phytoplankton) which makes up the major part of all life in the seas. It forms the basis for extensive and varied zooplankton, nekton and benthos.

Destruction by scavenger organisms and by aerobic bacteria is the usual fate of most organic life. By these processes the energy that originally came from the sun, and which was endothermically built into the organic matter, is exothermically released and lost. In this process the organic matter everts to the stable products, carbon dioxide and water, etc., from which it was derived.

In the two billion years or more of the earth's crustal history, the materials in the crust have been chemically "shaken down" to their most stable state. There are very few exceptions. But one of the principal of these is petroleum, which chemists look upon as metastable. With the application of but a small amount of energy, such as a spark or a flame, equilibrium is upset. When this happens the energy long stored in the petroleum or its products is exothermically released, as the hydrocarbons are changed back to the original stable compounds, carbon dioxide and water, from which they are derived. It is due largely to the anaerobic or oxygen-poor environments which existed in the silled or relatively deeper parts of restricted basins that this energy was preserved for us in the metastable form that is petroleum.

### *Conclusion*

Oil occurrence, in common with the sedimentary facies and like any natural phenomenon, is more directly controlled by the environment of deposition than by any other factor or combination of factors. The environment that exists on the deposition bottom and in the sediments directly below is dependent to a large degree on the basin bottom form or configuration and the supply of sediments. These, in turn, are mainly determined by the fundamental basin architecture or physical framework, which varies with the manner in which basins of different genetic types form and develop.

## *SECTION OF PHYSICS AND CHEMISTRY*

### THE CHEMICAL ATTACK ON TUBERCULOSIS*

*By* H. HERBERT FOX†

It has often been said that "man is his own worst enemy." This may or may not be true but it is certain that he has other enemies that vie with him for the title. One of the most pernicious of these and one which has plagued him since the dawn of history and beyond, is tuberculosis. It is not commonly realized that this "white plague" of olden days, this unremitting decimator of human populations all through the Middle Ages, is still one of the principal causes of death today. Actually, tuberculosis is responsible for more deaths of persons between 15 and 45 years of age than any other cause. We, who are properly horror-struck at the toll taken by war, ignore or forget that probably as many people are killed throughout the world every year by tuberculosis as were lost to the Allied Nations through combat during all the four years of World War I. Such is the magnitude of our enemy.

In view of these facts, it may appear that mankind has been unduly apathetic towards the disease. This may well have been true, but it was an apathy engendered by helplessness. Recently, the picture has been markedly changed and the disease has been subjected to vigorous attack

* This paper, illustrated with lantern slides, was presented at a meeting of the Section on April 7, 1953.

† Research Laboratories, Hoffmann-La Roche, Inc.

from many directions. One of the most promising lines of endeavor in the assault on tuberculosis lies in the field of chemotherapy with the new weapons which have been forged in the chemical laboratory. Before discussing these weapons, it is pertinent to consider briefly some of the factors which have made tuberculosis so difficult a problem in chemotherapy.

### *The Tuberculosis Problem*

The tuberculosis infection to which apparently all humans are susceptible is characterized by the formation in the tissues of nodular bodies or tubercles (hence tuberculosis). The causative agent, a fungus-like organism known as *Mycobacterium tuberculosis*, can and does infect practically any tissue or organ in the body so that in addition to the pulmonary form which accounts for about 90 per cent of tuberculosis, there are tuberculous laryngitis, enteritis, osteomyelitis, meningitis and a host of others including the rapidly fatal form known as miliary tuberculosis or "galloping consumption." The once popular term "consumption" had its origin in the fact that symptomatically, tuberculosis is a wasting disease and is generally characterized by a progressive weight loss.

It may seem strange that the successful chemotherapy of tuberculosis should have been delayed for so long. This has not been due to lack of effort. In the seventy years since Koch[1] isolated the organism, practically every chemical that has ever shown activity against any other organism has been tried in tuberculosis including, of course, the "sulfa" drugs and the common antibiotics. The fact is that until very recently all of them were without significant effect and the tubercle bacillus acquired the reputation of being a "tough bug."

When the organism is subjected to chemical analysis, a large nonsaponifiable wax fraction is obtained. This fact, taken in conjunction with its resistance to drug therapy and its ability to survive in the body for long periods, led some investigators to postulate that the tubercle bacillus was protected by a waxy capsule or envelope.[2, 3] On the assumption that penetration of the organism was an essential prerequisite for antituberculosis activity, it seemed reasonable to hunt for antituberculosis drugs amongst fat-soluble compounds which could diffuse through the waxy envelope. It is now apparent that this was a misconception of major proportions, since all the effective tuberculostats in current use are either water-soluble or are highly polar molecules of the type associated with water rather than fat solubility.

One of the differences between tuberculosis and the common bacterial infections lies in the relationship that exists between host and parasite. Most common bacterial infections are acute disease processes. The invading organisms grow to enormous numbers with great rapidity and the host's defensive mechanisms are quickly mobilized and brought into play against the invader. The struggle between the two forces is brief and fulminating and culminates in the destruction of either the host or the parasite. Tuberculosis, on the other hand, is a chronic disease. The tubercle bacillus is a slow-growing organism which, upon gaining entrance to a previously uninfected host, multiplies until sufficient resistance is developed within the host to bring the infection to a standstill. The dormant phase which follows may be permanent or, as too often happens, may give way to a reactivation of the disease. In any event, it is known that the organism can live for years in the host without provoking an all-or-none struggle.

In all probability, the chronicity of the tuberculous process is the crux of the tuberculosis problem. The successful chemotherapy of a disease becomes increasingly difficult as the disease process becomes more chronic. Flory[4] pointed out that staphylococcic osteomyelitis in its early stage is readily controlled by penicillin alone. In the later stages, when an abscess has formed, the pus must be drained before a satisfactory penicillin effect can be obtained. Finally, when the infection becomes chronic and dead bone is present, sterilization with penicillin is impossible and surgical removal of the dead tissue is essential. Similarly, in tuberculosis, extensive tissue destruction generally takes place and living, virulent bacilli become isolated within the cavities and amidst the debris of necrotic tissue. Tubercle formation also tends to wall off and isolate the organisms. At first blush, this would appear to be an entirely beneficial process in that it tends to check the spread of the infection. Actually, isolation of the colonies makes them potential

sources of reactivation of the disease and, what is perhaps most important, protects them from chemotherapeutic agents. Thus, it would appear that though the concept of a waxy capsule protecting the tubercle bacillus is untenable, the problem of getting the tuberculostat to the organism is still salient because of the mechanical barriers imposed by necrotic and fibrotic tissue, caseation, and incorporation of the bacilli in phagocytes. These unreachable foci of infection have practically precluded the use of the term "cure" in connection with tuberculosis if by "cure" we mean sterilization of the host. In this sense, it is quite unlikely that any drug or combination of drugs, regardless of activity, will ever be able to cure chronic tuberculosis.

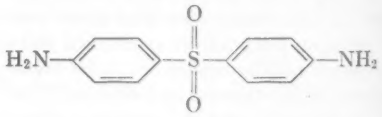
In addition to protecting the organism from tuberculostatic or tuberculocidal agents, relative isolation may also be responsible for the emergence of resistant strains, a phenomenon which has been a major stumbling block in the chemotherapy of tuberculosis. It may be postulated, that a colony which is not readily accessible may receive inadequate supplies of a drug so that, though most of its members are destroyed, a few resistant mutants may survive and flourish.

In the light of these considerations, it seems obvious that the ease with which a tuberculostat can diffuse through to the site of infection is as important in determining its ultimate efficacy as is high activity and low toxicity. Moreover, since the extensive tissue destruction that accompanies the chronic disease process complicates the problem immeasurably, it becomes axiomatic that early diagnosis and treatment are essential to successful chemotherapy.

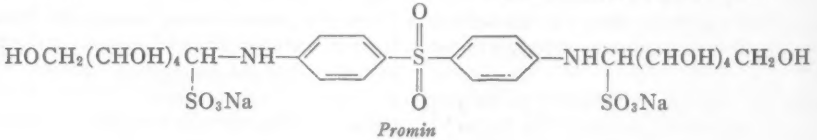
*The Synthetic Tuberculostats*

It is often convenient to divide the clinically effective tuberculostats into two classes: those which are elaborated in nature (the antibiotics), and those which are devised in the chemical laboratory (the synthetics). As chemists, our interests tend to lie with the synthetics because they lend themselves more readily to creative manipulation and their potentialities are limitless. Therefore, with due acknowledgment to the dominant role heretofore played by the antibiotic streptomycin, we shall here concern ourselves solely with the synthetic tuberculostats.

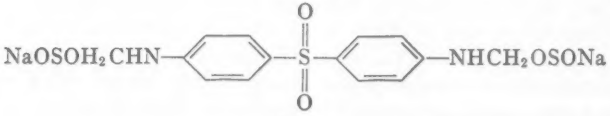
*The Sulfones.* The first compound to exhibit marked *in vivo* activity against the tubercle bacillus was 4,4-diaminodiphenylsulfone.[5] Unfortunately, it proved to be less effective in man than in laboratory animals and in addition, exhibited considerable toxicity. Despite its failure in clinical tuberculosis it has been used with some success in Hansen's disease.[6] Since DDS is insoluble and toxic, many attempts were made to synthesize sulfones with increased activity and solubility and decreased toxicity. Compounds such as promin,[7] diasone[8,9] and sulfetrone,[10] while more soluble and less toxic, are also less active and are therefore of doubtful advantage. Promizole[11] with a thiazole ring replacing one of the benzene rings of DDS appears to be somewhat better than the others.[12]




*4,4'diaminodiphenylsulfone (DDS)*




*Promin*

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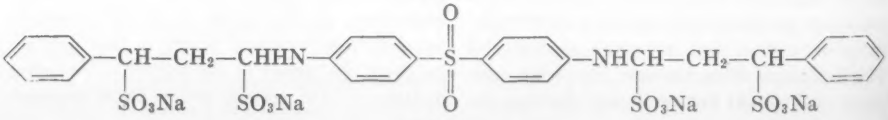


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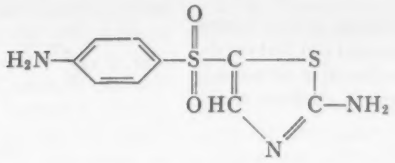
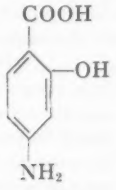


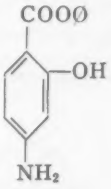
*Promizole*

*Amino Hydroxy Benzoic Acids.* In 1940 Bernheim[13, 14] observed that certain benzoates and salicylates increased the oxygen uptake of the tubercle bacillus. In 1944 Lehmann[15, 16] investigated the phenomenon and found that certain other compounds of related structures could decrease the oxygen uptake and inhibit the growth of the organism. The most potent of these is p-aminosalicylic acid, commonly known as PAS. As compared to streptomycin, the tuberculostatic activity of PAS is very low, but it has found wide clinical acceptance because it is relatively atoxic and because, when given in conjunction with streptomycin, it delays the emergence of resistant strains.[17, 18] Many variations in the PAS structure have been investigated but none is superior to the parent compound. Replacement of the hydroxy group with an amino or chloro group abolishes activity and shifting its position diminishes activity. Similarly, the amino group cannot be changed, shifted or alkylated, nor can the carboxy group be esterified without generally decreasing activity. One of the principal disadvantages attending the use of PAS lies in the fact that it must be given in large doses at frequent intervals because it is so rapidly excreted. To circumvent this difficulty, PAS has been administered with caronamide[19] and with Benemid.[20] However, the efficacy of Benemid in raising the blood level of PAS has recently been questioned.[21]



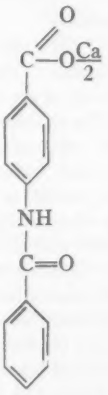
*PAS*

In addition, derivatives have been sought which are more slowly absorbed and eliminated. Among these is the phenyl ester of PAS known as FR7 which, according to the discoverers,[22] is no better than PAS orally, but is ten times more active than PAS and about equal to streptomycin when given subcutaneously to mice in either oil solution or aqueous suspension. This finding has recently been refuted.[23]



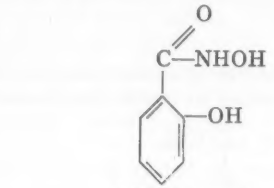
*FR7*

Another modification of PAS for which superior properties are claimed is calcium p-benzamidosalicylate.[24] Though inactive *in vitro*, it is supposed to be better than PAS clinically, because it produces sustained high blood levels of PAS without any of the latter's side reactions.

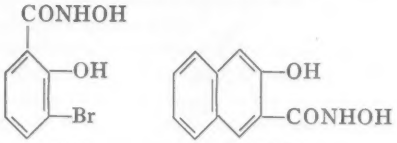


Equally equivocal is the claim by Urbanski[25] that salicylhydroxamic acid is tuberculostatic *in vivo*. This compound was prepared and tested in the Roche Laboratories and found without activity.[26] Nonetheless, very recently, Urbanski and his co-workers[27] in pursuing their studies announced that 3-bromosalicylhydroxamic acid (T40) and 2-hydroxy-3-naphthohydroxamic acid (T106) are very actively tuberculostatic in guinea pigs and, in fact, compare favorably with streptomycin. They also claim that (T40) is clinically

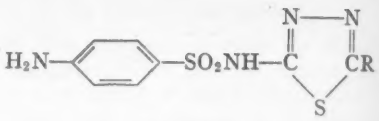
effective in tuberculosis meningitis, miliary tuberculosis and pulmonary tuberculosis and that radiological improvement can be achieved in the pulmonary cases. Whether others can duplicate these findings remains to be seen.



*Salicylhydroxamic acid*

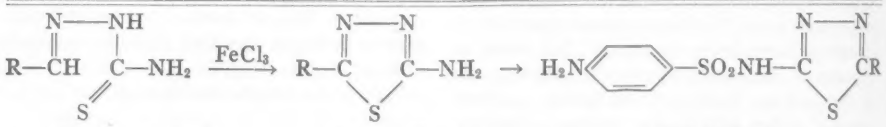


(*T40*) (*T106*)



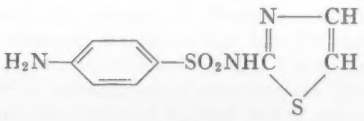
*Sulfathiadiazole*

The best known tuberculostat of the thiosemicarbone series is p-acetamidobenzaldehyde thiosemicarbazone (Tb I). Until the advent of the hydrazides, Tb I was the most active synthetic tuberculostat in clinical use. It has been extensively tested and used in Europe with apparently fair success in pulmonary and mucous membrane tuberculosis. Like PAS however it is ineffective in the deadly miliary and meningeal infections. Despite the glowing early reports from Europe, the compound has never made headway with American physicians for two pertinent reasons:

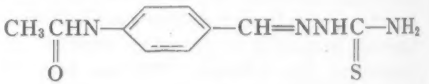


*R-Thiosemicarbazone* *R-Aminothiadiazole* *Sulfathiadizole*

*The Thiosemicarbazones.* The discovery of the tuberculostatic activity of the thiosemicarbazones was an outgrowth of a systematic investigation of the sulfa drugs in tuberculosis. Of the many sulfa drugs known, only sulfathiazole and sulfathiadiazole showed limited *in vivo* activity. In order to establish a relationship between structure and activity, Behnisch and his coworkers[28, 29, 30, 31] prepared a series of sulfathiadiazoles by cyclizing the appropriate thiosemicarbazone to the corresponding aminothiadiazole according to an established procedure[32] and condensing the aminothiadiazole with a substituted benzene sulfonylchloride. The end products proved to be of no value but struck by the structural similarity between the thiosemicarbazones and the aminothiadiazoles, they tested the former and found them to be strongly tuberculostatic.



*Sulfathiazole*



*Tb I*

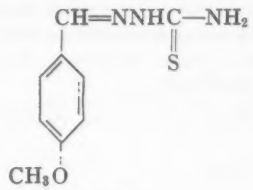
1. It is highly toxic and produces a multitude of undesirable side reactions, including gastric disturbances, blood dyscrasias and severe liver and kidney damage.

2. It came into direct competition in this country with the much superior tuberculostat, streptomycin which, it should be remembered, was not then available in Europe.

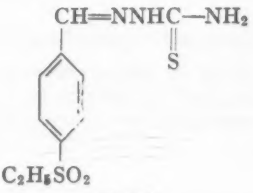
In the normal course of events, many variations have been made in the Tb I structure in an effort to obtain superior chemotherapeutants. Most of these changes have involved the character and position of the subordinate grouping since it was soon discovered the replacement of the thiosemicarbazone moiety by semicarbazones, hydrazones, azines, oximes and anils abolished activity.[33]

Shifting the position of the substituent grouping from the para to the meta to the ortho position generally results in decreasing activity in that order. The substituents can also be changed through a wide variety of structures without abolition of activity and, indeed, may be arranged in the following order of activity: ethylsulfonyl = isopropyl > amino = acetylamino = dimethylamino > nitro = sulfonyl = methoxy.

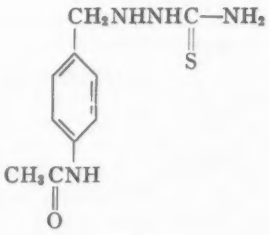
In addition to Tb I, the German workers have also clinically investigated p-methoxybenzaldehyde thiosemicarbazone (Tb II), p-ethylsulfonylbenzaldehyde thiosemicarbazone (Tb III), p-acetamidobenzyl thiosemicarbazone (Tb V) and the diethanolamine salt of p-carboxybenzaldehyde thiosemicarbazone (Tb VI).



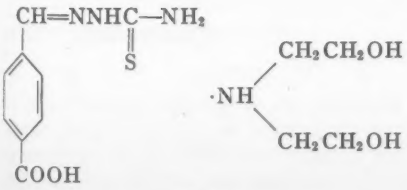
*Tb II*



*Tb III*



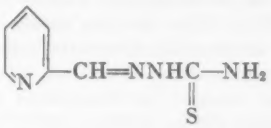
*Tb V*



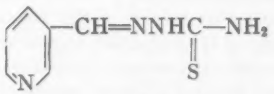
*Tb VI*

In the German view, none of these is superior to Tb I, but in England, the ethylsulfonyl derivative (Tb III) is regarded by some as more promising.[33, 34] However, a very recent study claims that Tb III is too toxic for clinical use in bone and joint tuberculosis.[35]

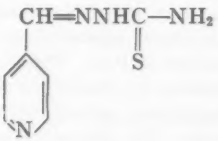
Extrapolation from the benzenoid to the pyridine systems has resulted in several interesting pyridine analogs of Tb I. Two of the three possible isomeric forms, isonicotinaldehyde thiosemicarbazone ($\gamma$ isomer) and picolinaldehyde thiosemicarbazone ($\alpha$-isomer) were first prepared by the author.[36] The $\beta$-isomer (nicotinaldehyde thiosemicarbazone) was independently prepared in Switzerland,[37] France,[38] and the United States.[39]



$\alpha$

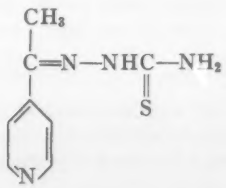


$\beta$

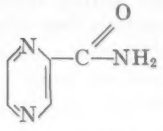


$\gamma$

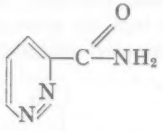
Picolinaldehyde thiosemicarbazone is too toxic for use but the $\beta$ and $\gamma$ isomers appear to be at least as active as Tb I [38, 40, 41] in intravenous mouse infections[42] and more active than Tb I in the intranasal type of mouse infection.[42] Of the pyridyl ketones, only the methyl-4-pyridyl ketone thiosemicarbazone[36] has shown activity though it is both less active and more toxic than either of the active aldehyde derivatives.



*The Pyridine Carboxylic Acid Derivatives.* The tuberculostatic activity of nicotinamide, the parent compound of this group, was first discovered in 1945 by Chorine[43] and by Huant.[44] Its activity approximates that of PAS but it has not been extensively tested, probably in fear of the toxic reactions which might occur at the high doses required. Chorine also tested nicotinic acid and found it inactive. He, therefore, correctly assumed that no relationship exists between the vitamin and tuberculostatic activities of nicotinamide. In one of those rare and inexplicable circumstances, this notable discovery passed unnoticed in this country. Three years later, the tuberculostatic activity of nicotinamide was rediscovered by McKenzie and Kushner and their coworkers.[45, 46] Upon studying some structures related to nicotinamide, these investigators found that the compounds which retained vitamin activity also retained anti-tuberculosis activity, whereas those without vitamin activity were also not tuberculostatic. On this basis they postulated that the two types of activity were interdependent. It is possible that because of this postulate and because none of the compounds in their series was more active than nicotinamide, they diverted their efforts from pyridine to other heterocyclic structures. Be that as it may, Kushner *et al.*[47] recently announced the discovery of pyrazinamide with a tuberculostatic activity approximately three times that of nicotinamide or PAS. Their findings have since been confirmed by others[48] who also reported on the tuberculostatic activity of the isomeric 3-pyridazinamide. The clinical potentialities of these two compounds appear distinctly limited; pyrazinamide, because of the rapid emergence of resistant strains[49, 50, 51, 52, 53] and pyridazinamide, because its activity is no greater than that of nicotinamide. Moreover, tremendous specificity exists between structure and activity for both diazines so that practically any structural deviation destroys activity.

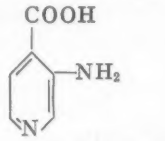


*pyrazinamide*

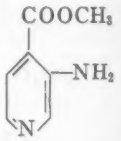


*3-pyridazinamide*

The apparent interdependence of the vitamin and tuberculostatic activities of nicotinamide motivated the author to a study of pyridine carboxylic acid derivatives closely related to nicotinamide.[36, 54] The results obtained early in the study appeared to confirm the existence of an interrelationship but subsequently, 3-aminoisonicotinic acid and its methyl ester were prepared and shown to have tuberculostatic activity without vitamin activity. From the standpoint of chemotherapeutants, these compounds are inconsequential, having as they do about one-half of the activity of nicotinamide. They are chiefly significant in having served to show that tuberculostatic activity in the pyridine field is not limited to derivatives of nicotinamide or to compounds with vitamin activity. Confirmation of this fact was quickly obtained with the development of the $\beta$ and $\gamma$ pyridylaldehyde thiosemicarbazones. These highly active compounds only proved to be stepping stones to the discovery of a new class of anti-tuberculosis agents which marks a major advance in the chemical assault on tuberculosis.

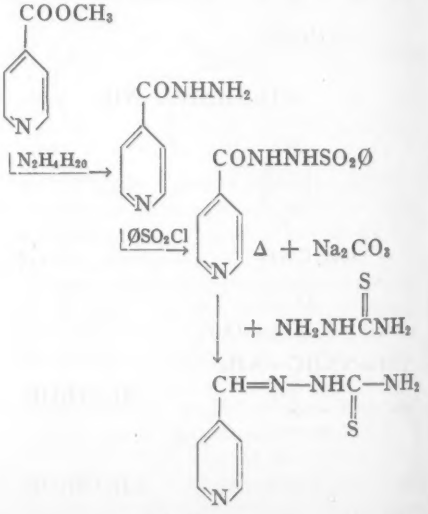


*3-aminoisonicotinic acid*



*methyl 3-aminoisonicotinate*

In attempting to prepare isonicotinaldehyde thiosemicarbazone by a modification of the McFadyen-Stevens reaction[55] the author[36] converted



*Isoniazid*

methyl isonicotinate to isonicotinyl hydrazine which was in turn converted to 1-isonicotinyl-2-benzenesulfonyl hydrazine. Alkaline decomposition of the latter in the presence of thiosemicarbazide yielded the desired thiosemicarbazone. Since isonicotinyl hydrazine (isoniazid) is a pyridine carboxylic acid derivative and is therefore already related to the structures being studied, it was investigated for tuberculostatic activity and was found to be more active than any known substance—whether synthetic or antibiotic.[54]

The activity of isonicotinyl hydrazine in mouse experiments using human strain H37Rv as contrasted with that of other tuberculostats is presented in TABLE I.

Extensive chemical and chemotherapeutic studies show that unlike 3-aminoisonicotinic acid, pyrazinamide or pyridazinamide, isonicotinyl hydrazine can be modified in many ways without abolishing its activity. Literally scores of its derivatives have *in vivo* activity greater than some of the earlier synthetics such as the sulfones and PAS.

Though it is too early to assess completely the role which isonicotinyl hydrazine and its derivatives will play in the control of tuberculosis, it is already apparent from the many clinical reports which have appeared since its advent, that it is one of the most potent—if not the most potent—single tuberculostat available and that it will constitute a very important factor in the future medical treatment of tuberculosis.

TABLE I

COMPARISON OF ACTIVITY OF KNOWN TUBERCULOSTATS WITH ISONICOTINYL HYDRAZINE*

| Compound | Route | $LD_{50}$[a] mg/kg | PD[b] I.V.† mg/kg | PD[c] I.N.† mg/kg | Ratio a/b | Ratio a/c |
|---|---|---|---|---|---|---|
| Streptomycin | Subc. | 970.0 | 25.0 | 100.0 | 38.8 | 9.7 |
| PAS | Per OS | 3750.0 | 1250.0 | >2500.0 | 3.0 | <1.0 |
| Nicotinamide | Per OS | 3750.0 | 885.0 | >2500.0 | 4.2 | <1.0 |
| Tb I | Per OS | 825.0 | 50.0 | 829.0 | 16.5 | 1.0 |
| Isonicotinyl hydrazine | Per OS | 203.0 | 4.6 | 6.2 | 44.1 | 32.7 |

* Data supplied through courtesy of Drs. Schnitzer and Grunberg.
† I.V. = intravenous infection. I.N. = intranasal infection.
$LD_{50}$ = dose killing 50% of mice.
PD[50] = dose protecting 50% of mice.

## *Conclusion*

The chemical approach to the treatment of tuberculosis, during recent years, has been encouragingly productive of new weapons and it is to be expected that the future will see further developments along these lines. Some day, we hope, tuberculosis will cease to be a major cause of human suffering and death. Until that day, however, chemists the world over will continue to search for compounds with those qualities which appear to be requisite to a clinically successful antituberculosis agent. Amongst these are easy diffusibility to the site of infection, which is, as we have seen, of utmost importance in a chronic disease such as tuberculosis. The compound should also be highly active, preferably *via* the oral route with bactericidal rather than bacteriostatic properties. Concomitantly, it should have a low order of acute and chronic toxicity to the host and particularly to those tissues in which it may concentrate. In addition, it should be slow to produce resistant strains since the ultimate efficacy of a drug varies inversely with the incidence of resistant mutants. Finally, it should be cheap to produce. Because tuberculosis is most common amongst the underprivileged peoples of the world, the importance of this last factor is obvious.

Isonicotinyl hydrazine conforms remarkably well to these criteria though the emergence of resistance may be somewhat more rapid than could be hoped for. The reports to date show that the compound is very active orally and is not very toxic. We also know it has superior intracellular penetrating powers and can get to tubercle bacilli even when they are growing within phagocytes.[57] This is in contradistinction to streptomycin and other antituberculous agents whose activity under such circumstances is sharply decreased. Presumably then, isonicotinyl hydrazine can penetrate to isolated colonies which are relatively inaccessible to other tuberculostats. Further support to this idea is supplied by the observation that $C^{14}$-labeled isonicotinyl hydrazine can and does penetrate

into the tubercles of tuberculous patients and has been found in the caseous center of such tubercles in significant amounts.[58]

Despite all this, isonicotinyl hydrazine is probably not the final answer to the control of tuberculosis. Indeed, it is doubtful that any one drug will be. In all likelihood, the chemotherapy of tuberculosis will resolve itself to a combination therapy of two or more effective tuberculostats, each of which will attack the bacillus via a different route to avoid cross-resistance and to block or retard the emergence of resistant strains.

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## *SECTION OF BIOLOGY*

# THE ACTIVITY OF CYTOCHROME OXIDASE DURING DIAPAUSE AND METAMORPHOSIS OF THE JAPANESE BEETLE (*POPILLIA JAPONICA* NEWMAN)*

*By* DANIEL LUDWIG†

Diapause is a resting condition in insect development which occurs independently of environmental factors. It is usually adaptive since it enables the insect to survive unfavorable environmental conditions. Bodine (1934) showed that the respiration of the pre- and post-diapause egg of the grasshopper, *Melanoplus differentialis*, is markedly inhibited by cyanide, whereas, the diapause egg is cyanide insensitive. Williams (1946, 1947, 1948a, 1948b) described diapause in the pupa of the moth, *Platysamia cecropia*, and postulated a mechanism whereby the brain and prothoracic glands may function in its termination. He found that diapause pupae are also insensitive to cyanide. He ascribed this insensitivity to a disruption of the cytochrome system. Diapause in this insect is associated with an almost complete absence of cytochrome c and cytochrome oxidase; and its termination with the restoration of the cytochrome system under the influence of hormones. When the neurosecretory cells of the brain become active, there is an increase in cytochrome oxidase which persists as long as the brain is active. Later, when the prothoracic glands become active under the influence of the brain hormone, cytochrome c is synthesized. Thus the diapause stage appears to be characterized by the absence of the cytochrome system, the terminal oxidase being a flavoprotein.

The cytochrome oxidase activity of diapause and metamorphosing Japanese beetles was measured spectrophotometrically by the method of Cooperstein and Lazarow (1951). All readings, except on the adult, were made on tissue homogenates at a final dilution of 1:1,000. Because of the high activity of the enzyme in newly emerged adults, readings on this stage were made at a dilution of 1:10,000. Larvae were reared at a constant temperature of 25°C. At this temperature, diapause always occurs in the third larval instar and lasts approximately 50 days, from the fifth to the twelfth week after the second molt. Cytochrome oxidase activity [expressed as $\Delta$ log (Cy $Fe^{++}$)/minute] is very low during the second and early part of the third instar, varying between 0.02 and 0.03. On the approach of diapause, its activity increases rapidly, reaching a high value of approximately 0.08. It remains at the value throughout diapause. During metamorphosis, cytochrome oxidase activity follows the characteristic U-shaped curve associated with oxygen consumption. It decreases very rapidly during the prepupal and early pupal stages, reaching a low value of 0.019 in insects 2 days after pupation. It then begins to increase, reaching 0.095 in the pupa just before adult emergence. The activity of cytochrome oxidase is much higher in the adult than it is in the larval or pupal stages. The average value obtained for 12 adult female beetles (calculated on the basis of 1:1,000 dilution) was 0.25; and for 9 males, it was 0.40.

These results indicate that diapause in Japanese beetle larvae may be physiologically different from that occurring in the egg or pupal stages of insects. Larval diapause appears not to be associated with a defect in the cytochrome system. Recent observations of Bodine, Lu, and West (1952) that the addition of sodium succinate to a homogenate of grasshopper eggs greatly speeds up the rate of oxygen consumption during diapause, but not during pre- and post-diapause, indicate that the succinoxidase system (which is believed to include cytochrome c and cytochrome oxidase) may be present although not active in the normal diapause egg. Levenbook (1951) reported that the respiration of diapause larvae of the horse bot fly, *Gastrophilus intestinalis*, goes through a cyanide and carbon monoxide sensitive heavy metal protein, probably cytochrome oxidase. Furthermore, MacDonald and Brown (1953) found that the diapause of the larch sawfly, *Pristiphora erichsonii*, which occurs in the prepupal stage, shows no decrease in cytochrome oxidase and no change in cyanide sensitivity. It appears, therefore, that in certain insects diapause may be controlled by some mechanism other than the cytochrome system.

The activity of cytochrome oxidase obtained for metamorphosing Japanese beetles is similar to that reported by Sacktor (1951) and by Bodenstein and Sacktor (1952) for the flies, *Musca domestica*, and *Drosophila virilis*, respectively.

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The low point in enzyme activity (pupa 2 days after the molt) reported in this paper, corresponds with the low point in the U-shaped curve for oxygen consumption reported by Ludwig (1931). These observations indicate that most of the oxygen consumption during the pupal stage is mediated through the cytochrome system.

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## *SECTION OF MATHEMATICS AND ENGINEERING**

### PRODUCTION PLANNING TECHNIQUES IN THE SHIPBUILDING INDUSTRY†

*By* GERALD PAUL STONE‡

The construction of major capital vessels by the shipbuilding industry is among the most complex of all engineering work. For this reason the most carefully worked out production planning techniques must be applied. If this is not done the alternatives are bottlenecks, interferences, delays, excessive costs, waste, and, finally being swamped in a sea of apparently unrelated details and actions. With this in mind, an understanding of the basic needs, in order to plan and schedule a shipbuilding program with real effectiveness, is necessary.

During World War II, I assisted in the development of a system of controls for planning and scheduling the aircraft carriers then under construction at the New York Naval Shipyard. From this association, my interest in the science of planning and scheduling grew to the point where I wrote my doctoral thesis on this subject at New York University. A clear visualization of the entire shipbuilding program is needed for effective production planning. The basic principles which have been developed apply not only to this industry but to any major construction or manufacturing program.

Planning is the first major phase of production planning. This generally starts with the award of a contract to construct a ship. Immediately, a group of related actions must commence. These begin with the setting up of the organization to carry out this task. Three functions have to be performed; planning the ship, building the ship, and controlling its construction. It is the integration of all these factors which result in a shipyard that operates at its optimum capacity.

The facilities of the shipyard must be suitable for the construction of the particular vessel. At times, this may involve additional cranes, power lines, railroad trackage, or storage areas. The vast majority of ship construction work is done in accordance with design drawings. The planning phase, therefore, requires the setting up of a

* The Section of Psychology held a meeting on April 20, 1953 at which a paper, entitled "Recent Developments in the Detection of Deception," was read by J. F. Kubis. This paper will be printed in a later issue.

† This paper, illustrated with lantern slides, was presented at a meeting of the Section on April 17, 1953.

‡ Associate Professor of Mechanical Engineering, Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

properly manned design section either at the shipyard or by a design agent. Working plans must be developed in sufficient detail so that material for the ship can be ordered, fabricated, and erected expeditiously.

In the 30,000 or so tons that comprise a major capital ship, are to be found practically all types of material. Steel is the principal element. Material comprising a typical ship of this type required more than 25,000 items, supplied by contractors from more than 24 states. Bills of material or B/M's as they are generally called, are used as the medium for transmitting the material information, authority for work, and the sequence of operations to the shops of the shipyard.

The keys to a successful shipbuilding program are the planning for, and control of, organization, facilities, plans, material, B/M's and manpower. The integration of all of these factors in a definite time interval, the construction period, produces the ship. Manpower considerations in ship construction, especially for capital vessels, are complex. There are more than one hundred trades performing much work of a highly specialized nature. These include boiler makers, caulkers, chippers, electricians, joiners, machinists, pipefitters, shipfitters, shipwrights, and welders.

Among the important functions of production planning is the determination of the number of persons required for the construction of the ship, together with the distribution of the trades. An overall estimate of the number of persons required is not sufficient because of their high degree of specialization. The pattern of trade distribution, furthermore, varies during the shipbuilding program. Accordingly, manpower planning assumes especial importance in the shipbuilding industry.

Physically, a ship is constructed in the interval between the laying of the keel and its final delivery. There is, in addition, a period between the award of the contract and the laying of the keel called the pre-keel period. In this interval, usually about six months, the major planning must be accomplished. The information available at the time of the award of the contract for the construction of a vessel must be used to develop a sound system of schedules. Generally, this data includes a set of contract plans, general and detail specifications. Scheduling is best subdivided into three phases; overall scheduling, master scheduling, and detail scheduling.

In the overall scheduling phase, it is necessary to consider the ship as a whole and to determine the target or cardinal dates for its construction. The cardinal dates which provide the overall perspective for the shipbuilding task are contract award, keel laying, launching, commissioning, completion of construction, completion of outfitting, and final delivery. These target dates provide the basis for the master and detail scheduling which follows.

It is a wise practice to issue schedules in terms of erection week numbers rather than for specific dates. This is due to the fact that there may be changes in some of the target dates. This was especially true during wartime conditions. Despite this, the general relationships specified in the schedules still stand. A control calendar can be used to express the relationship between calendar dates and erection week numbers. Rescheduling, due to cardinal date changes, can be done by modifying the control calendar alone.

With the information at hand during overall scheduling, the vessel is subdivided into the logical erection groups for ship construction. The basis is thus provided for all further scheduling to specific sections of the ship. Each erection group is bounded by transverse and longitudinal bulkheads and includes the overhead deck plating. Perhaps the most valuable single schedule is the overall structural, outfitting and completion schedule. The proposed sequence for constructing the ship is listed, taking into account physical locations on the ship. This overall schedule sets the limits by erection areas for plans; material, both structural and outfitting; shop fabrication; erection of structure; outfitting, such as machinery, equipment, wiring, and piping; and testing.

It is considered wise to limit this overall schedule to one sheet of paper wherever possible. In this way, the overall perspective for the construction of the ship can be maintained with simplicity. This overall schedule should be prepared as early as possible in the building period and before the laying of the keel. Work on it should be the first task following the setting of the cardinal dates and the logical erection groups. The major factors that have to be considered in its preparation are manpower requirements and availability, the particular type of design, the general material situation, shipyard facilities, and finally, the overall program of work for the shipyard. It is necessary to make as precise an estimate as possible of actual capabilities at this time. Every department in the shipyard must be consulted in order

*LEGEND*
E.S. – Erect Structure
O. – Outfit
F.C. – Final Completion (Paint, Test, etc.)

NEW CONSTRUCTION PLANNING AND SCHEDULING GROUP
CV 34 & 35 – ERECTION & OUTFITTING SCHEDULE

| FRAMES | INNER BOTTOM | | | WING TANKS | | | MACHINERY SPACES | | | HOLD | | | SECOND PLATFORM | | | FIRST PLATFORM | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | E.S | O. | F.C. | E.S. | O. | F.C. | E.S. | O. | F.C. | E.S. | O. | F.C. | E.S. | O. | F.C. | E.S. | O. | F.C. |
| Bow-26 | | | | | | | | | | 48-52 | 53-74 | 75-78 | 51-55 | 56-78 | 79-82 | 53-59 | 60-82 | 83-86 |
| 26-39 | 37-50 | 51-64 | 65-68 | 43-57 | 58-72 | 73-76 | | | | 46-50 | 51-73 | 74-77 | 49-52 | 53-77 | 78-81 | 50-57 | 58-81 | 82-85 |
| 39-50 | 34-37 | 48-63 | 64-67 | 40-55 | 56-71 | 72-75 | | | | 44-47 | 48-72 | 73-76 | 46-50 | 51-76 | 77-80 | 48-55 | 56-80 | 81-84 |
| 50-67 | 32-45 | 46-61 | 62-65 | 38-54 | 55-69 | 70-73 | | | | 41-45 | 46-71 | 72-75 | 44-47 | 48-75 | 76-79 | 46-54 | 55-79 | 80-83 |
| 67-79 | 31-43 | 44-59 | 60-63 | 37-52 | 53-67 | 68-71 | | | | 41-43 | 44-70 | 71-74 | 43-45 | 46-74 | 75-78 | 45-52 | 53-76 | 79-82 |
| 79-86 | 29-42 | 43-57 | 58-61 | 35-50 | 51-63 | 66-69 | 35-50 | 47-109 | 110-113 | | | | | | | | | |
| 86-93 | 28-41 | 42-55 | 56-59 | 34-49 | 50-63 | 64-67 | 34-49 | 46-109 | 110-113 | | | | | | | | | |
| 93-100 | 27-40 | 41-53 | 54-57 | 33-48 | 49-61 | 62-65 | 33-48 | 45-109 | 110-113 | | | | | | | | | |
| 100-111 | 26-39 | 40-52 | 53-56 | 32-47 | 48-60 | 61-64 | 32-47 | 44-109 | 110-113 | | | | | | | | | |
| 111-121 | 27-40 | 41-54 | 55-58 | 33-48 | 49-62 | 63-66 | 33-48 | 45-109 | 110-113 | | | | | | | | | |
| 121-131 | 28-41 | 42-56 | 57-60 | 34-49 | 50-64 | 65-68 | 34-49 | 46-109 | 110-113 | | | | | | | | | |
| 131-142 | 29-42 | 43-58 | 59-62 | 35-49 | 50-66 | 67-70 | 35-49 | 47-109 | 110-113 | | | | | | | | | |
| 142-150 | 31-43 | 44-60 | 61-64 | 37-50 | 51-68 | 69-72 | 36-50 | 48-109 | 110-113 | | | | | | | 45-50 | 51-78 | 79-82 |
| 150-166 | 32-46 | 47-62 | 63-66 | 38-52 | 53-70 | 71-74 | | | | 41-45 | 46-71 | 72-75 | 44-47 | 48-75 | 76-79 | 46-52 | 53-79 | 80-83 |
| 166-184 | | | | | | | | | | 43-46 | 47-72 | 73-76 | 46-50 | 51-76 | 77-80 | 48-53 | 54-80 | 81-84 |
| 184-198 | | | | | | | | | | | | | | | | 50-55 | 56-81 | 82-85 |
| Aft. 198 | | | | | | | | | | | | | | | | 53-58 | 59-82 | 83-86 |

FIGURE 1

that this overall schedule will be realistic. FIGURE 1 shows a form for this type of schedule.

With the completion of the planning and overall scheduling phases, the next step in production planning is master scheduling. It is at this point that specific job assignments are made. Master scheduling embraces plans, structure, shop fabrication, material, piping, machinery, electrical equipment, ventilation, outfitting, testing and painting. It, too, must be commenced during the pre-keel period and completed prior to launching the ship.

Master schedules for plan issue are prepared for the hull, machinery, electrical and other design work. The basic consideration is that the development of plans must proceed in accordance with the sequence in which they will be needed to order material, fabricate it, and install it aboard ship. There is a definite pattern in which a vessel under construction develops. This relationship between the growth of a ship and its material requirements makes it necessary that master scheduling for material be carefully done as early as possible. Among the factors which affect this scheduling are the procurement interval, lead time for supplying material, shop fabrication interval, the type of component and its size, the relative location on the vessel, and the time required for testing.

Shop fabrication master schedules require the determination of which work is to be done in the shops rather than aboard ship. Generally, it is desirable to accomplish as much work as possible in the shops. Therefore, this type of master schedule is usually prepared in conjunction with those for structure, machinery, ventilation, and the other types of work. Considerable advances in production planning techniques for shipbuilding have been made in this area. Sub-assemblies of the structure of the ship have been made in the shop with piping, fittings, foundations, and equipment installed, ready to be lowered into place on the building way.

The lead master schedule for specific work is the structural erection schedule. At the time of its preparation, the erection groups have been set, the overall pattern for ship construction has been determined, and agreement has been reached on the type of sub-assemblies to be shop fabricated. The usual practice for the erection of a ship's structure is to work from the center outboard, from the middle or midship section forward and aft, in progressive layers from the keel to the top. Keeping these considerations always in the forefront, the preparation of this schedule proceeds. The tanks and machinery space boundaries require an early start to enable the many outfitting trades to gain access to these spaces. By the determination of the total structural steel tonnage and the weekly tonnage rate, which may be a variable, this master schedule is developed.

The master schedules for piping, machinery, electrical installation, ventilation, outfitting, testing, and painting are in process of preparation at this time. Piping installations follow the structure very closely. This is due to their presence in practically every section of the ship. Machinery master schedules are prepared for work in the fire, engine, auxiliary machinery rooms, and miscellaneous compartments. Its scheduling is governed chiefly by the cardinal dates, receipt of the main units, the closing of the overhead decks, and the extent of the testing required. Electrical work, like the piping, is widespread throughout the ship. Of all the outfitting trades, the electrical can prove most critical. Especial care, therefore, is needed in electrical scheduling. Where this type of work does not get an early start with careful control throughout the installation, delay in the completion of the vessel is a definite possibility. In the master scheduling for these various types of work, coordination among all the trades, such as shipfitter, pipefitter, electrician, and machinist, is essential. Further, in order to be realistic, the schedules must be governed by the overall schedules, and plan, material, and manpower availability.

Detail scheduling is the next phase of production planning. In this phase of the work a great deal of judgment must be applied. The question to be resolved is the degree of detail to be followed in scheduling the work. A ship under construction, as has been previously noted, is a very complex engineering project. If an attempt were made to schedule in detail every single operation required for its erection, the cost would be prohibitive. Some of the effectiveness of the scheduling would be lost, due to over-controlling the work.

With these considerations in mind, detail scheduling by a central production planning group ought to be done only in those cases where it is necessary to insure the establishment of an orderly sequence of work with the proper coordination of plans, material, facilities, and manpower. There are certain types of work, however, which require scheduling in considerable detail. The preliminary compartment completion schedule is one of these.

Its preparation can be started as soon as the overall structural, outfitting and completion schedule has been made. Every compartment aboard ship is listed by number, description, and location. On this schedule, the erection weeks are specified for each compartment when structure is to be available for outfitting for the strength and tightness tests, for the final tightness tests, and for final completion of all work. This detail schedule is of necessity an approximate one. It is based upon the construction rate and pattern selected for the ship. With the use of this schedule a systematic and orderly rate of structural completion, compartment testing, fitting out, and final compartment close-out can be established.

Another valuable form is the plan cross-index. It provides a convenient index to the design plans that apply to each compartment. For structural work, a detail hull structure schedule can be prepared. It is based upon the overall and master schedules previously described. Its main value lies in the closer control of shop fabrication and ship erection of the various sub-assemblies. It is of the utmost importance that this detail schedule agree with the dates set on the other related schedules. It must be noted that the techniques for production planning in the shipbuilding industry are based upon extensions and developments from the primary schedules. Consistency is of importance.

In certain cases, it may be necessary to prepare a detail schedule for each step in the installation of a particular item. This type of schedule is called a special spot schedule. Its main use is for complex installations, such as the steering gear, machinery tests, and launching of the vessel. The other types of schedules may not provide sufficient control for this type of work. In many instances, the best place to prepare these special spot schedules is aboard ship where the job is to be performed.

The planning and scheduling techniques previously described result in the establishment of a systematic scheme for ship construction. The addition of the necessary controls leads to the best overall results. The types of control which have the greatest applicability are production control, cost control, manpower control, progress, and reports. The main purpose for production control is to aid and insure that the work is performed on time, with economy, and in accordance with the appropriate requirements. Material control is one of the fundamentals of production control. Great savings in labor and time have been obtained through a good system of material control.

Cost control is another useful technique. Its main emphasis has to be placed upon the dynamics of the shipbuilding program. With a sound system of cost accounting and feed-back of the necessary cost information, comparisons between the estimates and the actual expenditures can be made on a timely basis. Then these variances form the basis for constructive action in the shipbuilding program.

The successful control of manpower in the construction of a vessel is based upon careful planning and scheduling, together with the dispatching of men in accordance with these predetermined plans and schedules. The large number of trades involved in shipbuilding makes manpower control a difficult operation. For each ship under construction, manpower estimates are prepared based upon the contract, specifications, schedules and previous experience. These estimates are generally expressed in terms of average men per day and total man hours distributed by shops over the building period.

Various detailed analyses of the manpower expenditures for constructing a capital vessel have been made. Some of the results of this study will be briefly mentioned. The leading shop in constructing a ship is the shipfitter shop. It requires about 25 per cent of the total manpower. Next in magnitude is the welding shop with 12 per cent of the total. The electric, rigger and laborer, and pipe shops rank after the welders in that order.

During the period from start to launching the ship almost 50 per cent of the total manpower required is for shipfitters and welders. After launching, the electric shop requires the predominant amount of manpower, about 20 per cent of the total at that time. A comparison of the manpower expenditures from the start through launching with the period from launching through to completion reveals that the former period consists mainly of structural erection work, while the latter is chiefly outfitting. Ships may be launched at various stages of completion. The average manpower expenditures up to launching, for several capital vessels, were 70 per cent of the total. The work of the various shops is performed inside the shop, aboard the ship, or both. About 30 per cent of the total manpower requirements is for work in the shops.

The progress of a vessel under construction follows the normal growth curve very closely. It

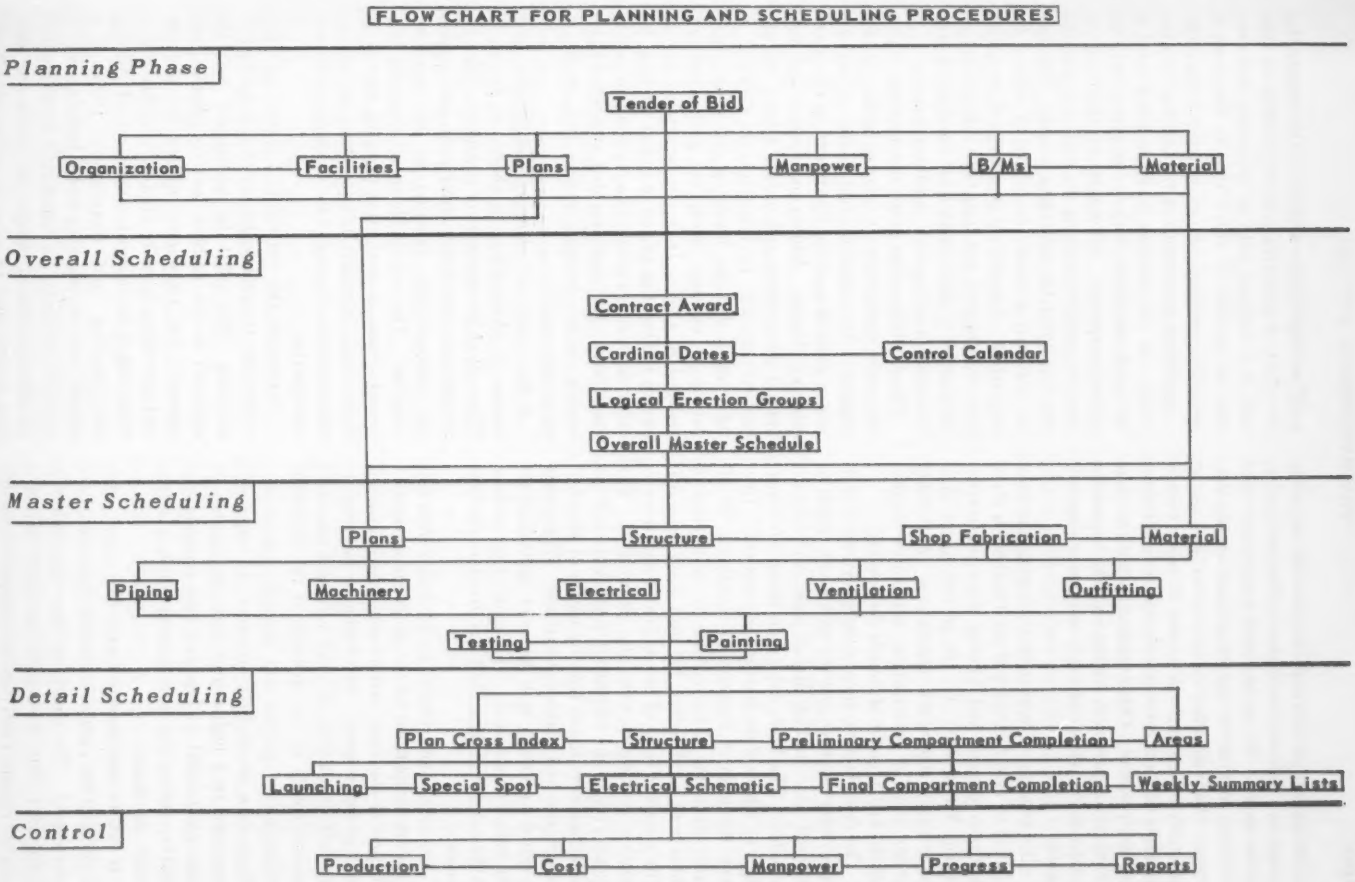
FLOW CHART FOR PLANNING AND SCHEDULING PROCEDURES
Planning Phase
Tender of Bid
Organization
Facilities
Plans
Manpower
B/Ms
Material
Overall Scheduling
Contract Award
Cardinal Dates
Control Calendar
Logical Erection Groups
Overall Master Schedule
Master Scheduling
Plans
Structure
Shop Fabrication
Material
Piping
Machinery
Electrical
Ventilation
Outfitting
Testing
Painting
Detail Scheduling
Plan Cross Index
Structure
Preliminary Compartment Completion
Areas
Launching
Special Spot
Electrical Schematic
Final Compartment Completion
Weekly Summary Lists
Control
Production
Cost
Manpower
Progress
Reports

FIGURE 2

is necessary to set up a definite system for reporting progress. This requires a standard nomenclature, understood by all the shipyard departments and the same method for reporting actual accomplishments. Various other reports prove of use in production planning. A report of work behind schedule with the reasons indicated, aids in following the progress. Other reports include tonnage erection, compartment testing, welding inspection, compartment close-out, and manpower expenditures.

The concept of operational analysis has been applied to escort carriers of the Casablanca class, destroyer escorts, and Liberty ships constructed during World War II. It reveals there is a statistically significant exponential relationship among time of construction, manpower requirements, and number of vessels constructed.

The three factors, time to construct the vessel, man hours required, and the number of vessels to be built were studied, first in pairs, and then all together. The basic data were fitted into equations by means of the least squares method. They took the form of exponential equations. In all cases the result of an increase in the number of ships built is to reduce the man hours required. The standard error of the estimates and the correlation coefficients were also determined. The significance of the correlation coefficients and the equations were tested both by means of students' distribution and analysis of variance. These tests revealed a generally high degree of significance for the values determined. The result of an increase in the number of ships built was to reduce the time required.

The conclusions which can be drawn from this data are complicated by the effect and interaction of each of the three factors considered; number, time, and man hours. In addition to studying the factors two at a time, all three have been examined simultaneously by an extension of the statistical techniques of partial and multiple correlation. These data reveal that manpower is negatively correlated to a high degree with the number of ships constructed. There is a high multiple correlation among the three factors which is statistically significant.

It can be conclusively stated that time, manpower, and the number of vessels constructed are interrelated. The nature of this relationship is exponential, with the number generally having a negative exponent and time and manpower positive exponents considering manpower and time separately as dependent variables. This means that the effect of an increase in the number of ships built is a decrease both in manpower and time. Also, an increase in either time or manpower is generally associated with an increase in the other.

Significant conclusions can be drawn from this study. As the number of ships constructed is increased, reductions both in manpower and time are to be expected. Allowances for this reduction must be provided in doing the necessary planning and scheduling for succeeding vessels. This fact has not been generally considered or allowed for in practice. Secondly, if the expected reductions both in manpower and time fail to materialize, as the number of ships constructed increases, it is an immediate warning that something is wrong.

There is little value in piling manpower onto a ship under construction in order to reduce the time required. Very often the real sources of delay are lack of plans or material which hold up the proper sequence of work. Adding manpower in bulk does not aid this problem and usually hinders efficient construction due to interferences, difficulty in supervision, and the tendency for each man's output to decrease when too many men are assigned to a job. It is not considered wise to stretch the building period of a ship too long, because the evidence points to a resulting increase in manpower. This indicates that an artificial prolonging of the building period also results in manpower waste.

A flow chart for planning and schedule procedures in shipbuilding is shown in FIGURE 2. When all of the elements of production planning are properly considered, understood, and applied, the shipyard can function at its maximum potential. The real dividends of a soundly conceived system of production planning include reduced costs, decreased building times, and elimination or easing of many of the physical problems of construction.

To conclude this discussion, it is felt imperative to describe the philosophy underlying production planning. This must be understood that the approach to the problem and its solution may succeed. The techniques outlined for planning and scheduling must be applied, together with a tempering of the necessary ingredients of patience, understanding, and cooperation. There is a natural pace to planning and scheduling, and it cannot be rushed. To function at anywhere near its potential level of benefit, the production planning section must be aware of and conscientiously apply this philosophy to the program.

# STUDIES OF REVERSE MUTATION IN *NEUROSPORA CRASSA**

*By* NORMAN H. GILES†

Biochemical mutants in *Neurospora crassa* have proved to be exceedingly useful material for analyses of the genetic mechanisms of reversion. The term reversion is used as a general one to designate changes giving rise to non-requiring (prototrophic) variants in mutant strains which initially exhibited specific growth factor requirements.

By the use of appropriate strains (with uninucleate conidia), treatment conditions, and plating techniques it is possible to obtain reasonably precise quantitative data on the frequencies of induced reversions in various biochemical mutants. The detection of reversions is very efficient, though the frequency of the change which is being studied may be quite low; for example, one in $10^6$ surviving conidia, since the new growth-factor-independent types are automatically selected in a medium lacking the particular factor from among the large population of unchanged, dependent conidia. A detailed discussion of the procedures in such induced reversion tests has been presented elsewhere (Giles, 1951) and will not be repeated here.

Genetic analyses of spontaneous and induced reversions in various biochemical mutants of *Neurospora crassa* have demonstrated that two principal types of changes are involved—reverse mutation and suppressor mutations (Giles, 1951; Giles and Partridge, 1953). In studying any particular mutant giving rise to reversions, crossing analyses are necessary to establish the genetic basis of the types encountered. In the investigations to be summarized here, crossing evidence indicates that the majority of the reversions arise by reverse mutation. In the case of inositolless mutants, suppressor mutants also occur, but in most instances, these can be distinguished phenotypically from reverse mutants. In studies with purple adenineless mutants, no suppressors have yet been detected.

Extensive physiological and biochemical studies of reverse mutant strains in inositolless mutants have shown that these reversions are usually quite similar to the original inositol-independent wild types. Such strains synthesize inositol and have growth rates on minimal similar to that of wild type. Instances are known, however, of partial reversions which are not exactly like wild type. In a study of X-ray induced reversions in one inositolless mutant—89601—(Giles, 1951; Giles and Partridge, unpublished), in addition to typical reverse mutations, a partial reverse mutant type intermediate between the inositolless and inositol-independent types was encountered. This mutant grows on minimal but is markedly stimulated by

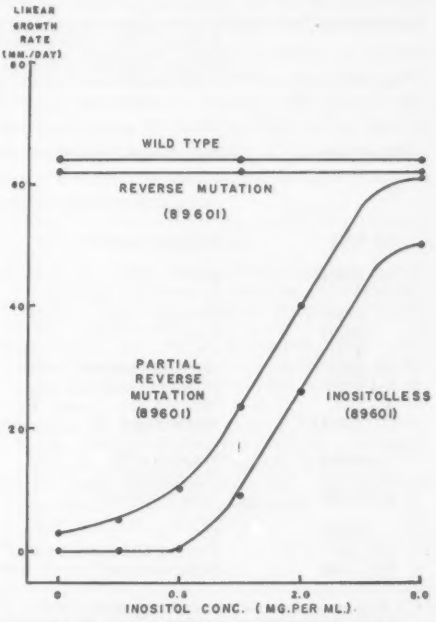


FIGURE 1. Linear growth rates with increasing inositol supplements of a complete and a partial reverse mutant (induced by X rays in inositolless mutant 89601) compared with wild type and inositolless 89601. All strains with wild type morphology.

the addition of inositol to the medium (FIGURE 1). Genetically, the partial as well as the complete reverse mutant types show similar, normal linkage relationships with adjacent loci. The occurrence of such types (especially the intermediate allele) provides evidence that X rays as well as ultraviolet rays can induce dominant changes that are most simply interpreted as arising from true gene mutations.

In addition to providing data on the occurrence and characteristics of complete and partial reverse mutations, investigations of reversions at specific

* This paper, illustrated with lantern slides, was the second of two papers presented at a meeting of the Section on April 24, 1953. The first paper, "The Role of the Gene in Cellular Biochemistry" by David Bonner, had not been received at the time of publication.

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loci in *Neurospora crassa* have supplied evidence for the existence of isoalleles (Stern and Schaeffer, 1943) in this mold. Studies of eight independently induced, allelic (or, in some instances, possibly pseudoallelic), inositolless mutants have indicated that these mutants are phenotypically and biochemically indistinguishable. They may, however, be distinguished on the basis of inherited, autonomous differences in their rates of spontaneous or ultraviolet-induced reverse mutation (Giles, 1951; Giles and Partridge, 1953, and unpublished). Similar studies have now been made (de Serres and Giles, unpublished) with 7 additional allelic inositolless mutants, one of which is a temperature-sensitive mutant (the author is indebted to Drs. G. W. Beadle, W. D. McElroy and C. M. Stevens for certain of these mutants). All these data are summarized in TABLE 1. It is clear that there are marked differences in reverse mutability, such that at least five distinct groups of mutants exist. Genetic evidence, using linked markers, shows that, where tests have been made, these differences segregate regularly at meiosis and are characteristic of the particular mutants (Giles, 1951). The designation of this series of mutants as isoalleles arises from the fact that this special difference in the frequency of reverse mutation is the only one which permits a regular distinction to be made among these mutants, with the exception of the one temperature-sensitive type.

Recently, experimental evidence has been obtained for a similar isoallelic situation at another locus, the purple adenineless locus. Comparative studies have been made of five purple adenineless mutants of independent origin (Giles and Partridge, unpublished). Biochemical, heterocaryon, and other genetic tests made to date have detected no differences among these mutants, with the possible exception of mutant 68306 which is being examined further. Typical growth curves for four of the mutants are shown in FIGURE 2, where their marked similarity is evident. Comparative frequencies of reverse mutation in the five mutants have been determined for one standard ultraviolet dose (TABLE 2). The data demonstrate that the mutants comprise at least two separate categories with respect to induced reverse mutation frequencies. Preliminary genetic evidence, using

TABLE 1

COMPARATIVE SPONTANEOUS AND ULTRAVIOLET-INDUCED REVERSE MUTABILITY OF INDEPENDENTLY INDUCED, ALLELIC, INOSITOLLESS MUTANTS IN *NEUROSPORA CRASSA*

(Values represent, in general, averages of several experiments)

| Mutant Number | Original mutation produced by | Reverse mutation frequencies per $10^6$ surviving conidia | | | | Tentative Group Number |
|---|---|---|---|---|---|---|
| | | Macroconidia | | Microconidia | | |
| | | Spontaneous | U.v.-induced | Spontaneous | U.v.-induced | |
| JH 5202 | Nitrogen-mustard | 15.0 | — | 15–726 | — | I |
| 37401 | U.v. | 0.02 | 10.0 | 0.01 | 3.5 | II |
| 37102 | U.v. | 0.01 | 3.8 | 0.01 | 1.1 | III |
| 64001 | U.v. | 0.1 | 1.0 | 0.05 | 0.4 | |
| 46316 | U.v. | 0.02 | 0.2 | 0.01 | 0.3 | |
| JH 2626 | Nitrogen-mustard | 0.01 | 1.6 | 0.01 | 0.2 | |
| JH 5652 | Nitrogen-mustard | — | — | 0.0 | 0.08 | |
| WS 5-71 | Mustard gas | 0.0 | 0.21 | — | — | |
| 83201* | Mustard gas | — | — | 0.05 | 0.14 | |
| 89601 | Mustard gas† | 0.002 | 0.05 | 0.007 | 0.008 | IV |
| WS 4-25 | Mustard gas | 0.0 | 0.07 | — | — | |
| WS 7-330 | Sulfur-mustard‡ | 0.0 | 0.01 | — | — | |
| 46802 | U.v. | 0.0 | 0.0 | 0.0 | 0.0 | V |
| JH 319 | U.v. (or nitrogen-mustard)** | 0.0 | 0.0 | 0.0 | 0.0 | |
| WS 7-366 | Sulfur-mustard‡ | 0.0 | 0.0 | — | — | |

* Temperature-sensitive mutant; platings made at 35°C.
** Derived from combined treatment with u.v. and nitrogen-mustard; latter in relatively non-mutagenic concentrations.
† Previously reported, in error, as nitrogen-mustard.
‡ Sulfur-mustard = n butyl 2 chloroethyl sulfide.

TABLE 2

COMPARATIVE SPONTANEOUS AND ULTRAVIOLET-INDUCED REVERSE MUTABILITY OF INDEPENDENTLY INDUCED, ALLELIC, PURPLE ADENINELESS MUTANTS IN *NEUROSPORA CRASSA*

(Values represent averages of two or more experiments)

| Mutant Number | Original mutation produced by | Reverse mutation frequency per $10^6$ surviving microconidia | | Tentative Group Number |
|---|---|---|---|---|
| | | Spontaneous | U.v.-induced* | |
| 38701 | U.v. | 0.07 | 0.64 | I |
| 38709 | U.v. | 0.1 | 0.51 | |
| 68306 | U.v. | 0.03 | 0.42 | |
| 35203 | U.v. | 0.006 | 0.08 | II |
| 45601 | U.v. | 0.02 | 0.07 | |

*Standard ultraviolet dose, *ca.* 1000 ergs./mm.$^2$ at 5 ergs./mm.$^2$/ sec.

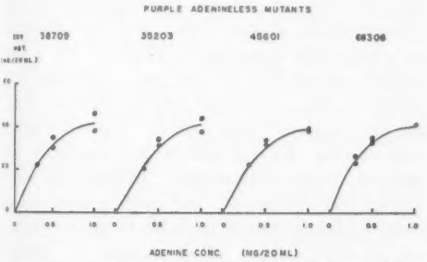


FIGURE 2. Comparative growth responses in flask tests of four independently induced, allelic, purple adenineless mutants.

linked markers, has also been obtained that the control of these reverse mutation frequency differences is autonomous, i.e., characteristic of a particular mutant locus, and results from conditions at that locus, rather than from the effects of modifying factors at other loci affecting reversion frequencies.

These results with allelic purple adenineless mutants indicate that the earlier finding of isoalleles at the inositolless locus does not represent a unique situation in *Neurospora*. In fact, it seems probable that the quantitative comparative reversion technique would demonstrate the existence of mutability isoalleles at many additional loci where otherwise indistinguishable replicate mutations have occurred. Actually this initial interpretation of the differences in rates of reverse mutation among replicate mutants at these loci in terms of a series of isoalleles is probably too simple. Preliminary evidence exists that at least the inositolless locus may be structurally compound (Giles, 1951; and unpublished). Only much additional experimental evidence will permit any final conclusions to be drawn concerning what is obviously a basic, but inherently a complex problem—the nature of mutational changes—even at only a single genetic locus.

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## *SECTION OF ANTHROPOLOGY*

### THE APPLICATION OF PSYCHODRAMA TO RESEARCH IN SOCIAL ANTHROPOLOGY*

*By* JOSEPH BRAM†

In discussing the application of the psychodramatic method to research in social anthropology it is well to keep in mind that the term social anthropology means different things to different people. Thus, it may be useful to state that, for all present purposes, social anthropology will be used here to refer to a comparative study of human behavior in different societies.

Having said that much, one is still under obligation to define what kinds of behavior one wants to study. Behavior is a very comprehensive term which refers to the totality of motor-events that occur in individuals. As social scientists, anthropologists are more specifically interested in the ways human beings behave toward each other, or in respect to each other; i.e., in interpersonal relations.

Being intrigued, amused, or saddened by the varieties of human behavior may justify the desire

* This paper was presented at a meeting of the Section on April 27, 1953.

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to observe it. The determination to make it a subject of study, however, must be based on the assumption that the data lend themselves to a certain amount of systematization, i.e. that there is some order in this chaos. As students of social behavior, anthropologists believe that they have been able to identify recurrent, coherent and predictable forms of behavior, at least for specific cultures and limited periods of time. To this conviction they have added the theoretical notion that regularity and consistency of behavior in any given human group may be viewed as growing out of socially shared images and patterns of behavior. The totality of these patterns is subsumed under the overall term "culture."

Now we have to define what we mean by the comparative study of man's behavior, and what the purposes of such study are or could be. I should like to inject here a somewhat unconventional distinction between two varieties of comparativists, as I see them, whom I would call respectively "optimists" and "pessimists." The "optimists" believe that the diversity of cultures conceals an underlying limited range of social mechanisms, and that the ultimate reward of the student of human societies will be an overall theory of social action as consistent and systematic as the table of elements or the laws of genetics. The label of a "pessimist" in this context, would be attached to the scientist who prefers to limit his expectations of consistent and predictable behavior to any particular society.

To translate this distinction into concrete terms, let us take the study of juvenile delinquency. The "optimist" looks forward to a comprehensive theory of delinquent behavior and hopes that it will contain universally valid predictive, preventative, and therapeutic implications. The "pessimist," on the other hand, maintains that, in the very best case, we shall arrive at a limited theory of delinquent behavior; for example, for the United States between 1950 and 2000 A.D.

As a group, American anthropologists have been more impressed with the psychological uniqueness of different human cultures than most of their French or British colleagues. American research in anthropology has been focussed on the process of diffusion and the specificity of culture areas (Wissler, Kroeber, Dixon); on the reconstruction of specific historical sequences (Boas, Radin, Spier, Sapir); on cultural configurations (Benedict); on culturally determined personality types (Hallowell, Mead, Linton, Kardiner, Erikson); on cultural value-systems (Kluckhohn, Laura Thompson), and the like. The accent has been placed on cultural diversity, and theorizing has pursued the possibility of accounting for the multiplicity of lifeways and character structures.

This paper is in sympathy with the general orientation of American anthroplogy, and is intended as a modest contribution to the storehouse of techniques for the study of diverse patterns of behavior. The method proposed here is not meant to be a substitute for any of the known and tested ways of studying human behavior. I believe, however, that it possesses some qualities which are not present in other methods and that, therefore it can be used to supplement those now in use.

Field work in residence among the people studied, which, to this day, remains the most effective form of cultural investigation, is not without serious shortcomings. The time allotted for a field-study is necessarily limited. The field-worker's personality, i.e. age, sex, individual peculiarities, etc., inevitably creates selective and specific "rapports" with natives. The very presence of the observer affects the character of behavior under observation. Thematically significant occurrences do not always take place when the field-worker is available to observe them, nor do they happen often enought to justify relevant generalizations.

These remarks should not be misunderstood as denying value or validity to hard-earned monographic studies by hundreds of dedicated anthropologists. Their purpose is rather to underscore the notion that no royal road has been found in the study of human behavior, and that human actions—this most elusive type of reality—might perhaps yield some of their secrets to a novel and unorthodox technique.

The method proposed here for consideration is not really new, in fact it is over thirty years old. But the element of novelty is the suggestion that this technique should be used for the comparative study of cultures, whereas it was devised originally for substantially different purposes.

The early phase in the development of psychodrama need not concern us here too long. As a young man, Dr. Jacob L. Moreno combined his professional medical activities with a profound interest in philosophical and esthetic ideas and experiments. From his own writings, one gathers the impression that the guiding impulse behind this involvement was a romantic protest against the encapsulation of human vitality in the shell of

cultural conventions. Poetry, religion, and children, he felt, were a reminder to men what they could have been, had they not surrendered their spontaneity to industrial civilization. But it was the theatre that struck Dr. Moreno as offering an ideal combination of an almost unlimited freedom for poetical improvisation with the possibility of re-enacting lifelike situations in all their essential authenticity.

In 1908 he started experimenting with groups of children, in 1911 he founded in Vienna the Theatre for Children, in 1921 he inaugurated the first psychodrama at the Komoedienhaus of the same city. In 1925, Dr. Moreno came to the United States where he has continued as a psychiatrist, a research scholar, a writer and a teacher. In 1936, he built his first American theatre of psychodrama in Beacon, New York, followed in 1942 by another Theatre of Psychodrama at his Institute in New York City. In the meantime, psychodramatic techniques have been adopted by numerous mental hospitals, and have also, in various forms, become identified with the fast growing movement of group psychotherapy.

It is not, however, the psychiatric aspect of Dr. Moreno's work that justifies my bringing psychodrama to the attention of anthropologists. I first went to his Psychodrama Theatre to satisfy my general exploratory urge. But after three or four sessions, I suddenly became aware of the fact that here was a wonderful tool for a cross-cultural study of human behavior. Not feeling competent to pass judgment on the psycho-therapeutic effects of the method, I became interested in its potentialities as a tool for anthropological research. In this connection I suggested to Dr. Moreno that psychodrama, when used in this context, should perhaps be identified under a separate name, such as ethnodrama. Dr. Moreno approved the idea and authorized me to bring my students from New York University to his Psychodrama Theatre for independent experimental sessions. In the meantime, I continued attending the weekly sessions at the Institute and also took advantage of the Beacon Workshop for Training in Psychodrama. Thus, the discussion which is being offered here is based on direct experience with some two dozen sessions, six of which I conducted personally. During this period I became aware of some of the difficulties and limitations of the psychodramatic method, but I also discovered many of its unsuspected potentialities.

In order to be effective, a psychodramatic session requires the presence of one or several protagonists and a small audience out of which, as the need arises, one can recruit auxiliary performers, whom Dr. Moreno calls "auxiliary egos." The session is conducted by a "director." The role of the audience is to provide all the emotions that are associated with group functioning. Every effort is made to involve the audience in the happenings on the stage. The alpha and omega of psychodrama is symbolized by the word "spontaneity." In order to induce this state of mind in all those present, the director initiates the session with various "warming-up" techniques for which there is no one standardized formula. The first few minutes may appear embarrassing, as happens commonly in social life, at parties, at banquets, on dates, etc. Before long, however, one or two participants respond to the director's efforts, and then, in an amazingly short time, the session gets under way, and all those present are likely to find themselves engrossed in a lifelike situation being acted out on the stage.

The term "stage" should not be understood too literally. What is designated by this word is nothing but a raised platform, semicircular or otherwise, furnished with a few chairs and one or two small tables. There is no need for a curtain or any elaborate props. Limited lighting effects may be useful in order to differentiate between broad daylight moods and situations as opposed to an atmosphere of dusk and intimacy. If, in the course of the action, the protagonists are supposed to be manipulating the telephone, the radio, or the piano, reliance is placed on their ability to suggest the presence of these objects. I have seen family dinners, dancing parties and auto rides across the countryside acted out most effectively with no other props than the few chairs and desks on the stage.

Facility in self-expression and freely-flowing emotions are stimulated by the subtle but cumulative effect of what one could describe as immersion in common humanity. Human failings, such as insecurity, vanity, hostility are faced openly. The feeling of all men being "in the same boat" communicates itself to the group and the two or three steps separating the raised platform from the audience cease to be a barrier between the "actors" and the public.

The first time I tried the method, I picked the theme of parent-child relationship. The group had met for the first time. We began awkwardly and haltingly at about ten o'clock in the morning,

but an hour later, one could have found a hushed audience watching the re-enactment of truly dramatic experiences volunteered by one of the participants. The last part of that session and the two sessions which followed gave every member of the group a chance to contribute at least one episode from the story of his relationship with his parents. We saw a long series of parents—strong and weak, loving and rejecting, secure and anxious—in their dealings with their children. Several members of our group were of Anglo-American Protestant ancestry, others were of relatively recent Eastern-European, Jewish ancestry. In addition to these two sets, we had among our participants individual representatives from Puerto-Rico, Venezuela, Yugoslavia, Iran, Vietnam, etc.

Limited as our sampling was for any scientific purposes, the happenings on the stage began to fall into significant cultural grooves. Thus, we noticed that conflicts in Protestant Anglo-American families, as acted out on the stage, were characterized by verbal parsimony, an obvious air of embarrassment and attempts to conceal emotions. The Jewish-American patterns of family conflicts, on the other hand, were rich in explosive verbalism, open self-dramatization and uninhibited exposure of the underpinnings in family relationships.

We took notice also of the reasons and pretexts for which the conflicts were staged as well as of the culturally significant symbols to which the antagonists resorted. Thus, we noticed that our Protestant Anglo-American adolescents, in opposing their parents, fought for their "rights," whereas our Jewish-American protagonists were more often struggling to free themselves from their strongly internalized "duties" towards their families. Needless to say, these observations are not being reported here as definitive findings, but as samples of discoveries which the method makes possible.

Since every family conflict was represented in our group by one of its original participants only, other members of the family had to be impersonated by "auxiliary egos" from the audience. The auxiliary egos had to be instructed by the central protagonist as to the way his father or mother acted under the circumstances of the case. This could be done either before or after they began acting their role. The burden of re-enactment is thus carried by the main protagonist, which is only legitimate since it is his image and interpretation of the situation that the group wants to understand.

We did not limit ourselves, however, to the re-enactment of the family conflict as it presumably occurred in real life, but gave our protagonists a chance to experiment with reality. Thus, they were requested to demonstrate how they would have wanted their father (or mother) to act in the scene under consideration. They were also given the opportunity to show how they wish they had acted.

From time to time, the director of the session would ask protagonists to "soliloquize"; i.e., to speak aloud as many of their thoughts as they could remember in connection with the scene which was being re-enacted, or even to "soliloquize" for their antagonists. In this last case, they obviously had to use whatever insights they might have into the minds of those with whom they were in conflict.

If the logic of the situation became quite obvious to the group, but was not acknowledged by the protagonist, unwilling to carry its implications too far, the director provided him with an *alter ego*. The *alter ego* shadowed and doubled the protagonist but in his suggestions, remarks and admissions, went just a step further. Thus, the protagonist was confronted with embarrassing or inadmissible implications of his own words or actions, which he was, of course, free to repudiate.

In order to make this re-enactment procedure fruitful for socio-anthropological purposes, it is essential to have a group of participants from the same socio-cultural background. In such a case, the ego, his auxiliary egos, and his *alter egos* combine with the audience in reproducing a dynamic picture of inter-actional roles as they prevail in that culture. Advice, gestures and intonations are freely suggested, acknowledged or qualified. One finds oneself in the presence of a *dynamic group interview* or one may call it an "action seminar," out of which the anthropologist can infer the system of shared meanings, i.e., the cultural "field" in terms of which the informants have organized their existence.

The data obtained by this method should, of course, be checked with some outside members of the same socio-cultural group. They can be amplified also through intensive individual interviews and enriched by other relevant materials within the researcher's reach.

It is unwise to keep the group to any rigid schedule of themes. Instead, one should be pre-

pared to range over a wide territory, as long as one is aware of the basic outline of the project. On one occasion, I had met with a group with a specific assignment in my mind, when suddenly one of its members started telling us a story of how embarrassed she was as a child when her mother had arranged for her to have a meal with the Italian family of a schoolmate. The case was acted out very vividly and was followed by an avalanche of intercultural episodes involving gastronomic and dietary differences between Americans, Iranians, Venezuelans, etc. Such outbursts of *spontaneous* group creativity should take priority over any prearranged schemes.

Psychodrama is based on action and actors, and one may wonder whether traditional verbal interviews could not be just as informative and effective. There are several arguments in support of the importance of the re-enactment technique. Verbal accounts, unless delivered by gifted story tellers, have a limited evocative value and fail to bring forth the group contributions, which are one of the major features of all psychodrama. Also, in telling a story, one can cover such a vast territory in a few minutes that the listener is left with an evanescent impression of the situation under study. Then, again, speech is so often used for purposes of concealment and self-justification that a strictly verbal interview may not possess the authenticity and the emotional quality which the acting out of a true situation usually displays. After all, we all know that fairly mediocre plays, where the content, or social message, could be summed up in five minutes, frequently get all our attention and involve us emotionally when we see them on the stage.

During one of the regular sessions at Dr. Moreno's Institute, we sat spellbound before a man acting out the first breakfast of his married life. The conversation between him and his bride was about coffee and scrambled eggs, whereas we knew that they were making every effort to conceal from themselves and from each other that their marriage had been a mistake. Psychodrama is unusually rich in such poignant insights into human situations.

One of the many advantages of the psychodramatic method at the service of social anthropology is the fact that it lends itself well to team work by several researchers. The subjective element in the observation and the interpretation of the data is thus considerably reduced. One approximates the ideal of the natural sciences, where findings and observations can be reproduced a number of times for purposes of verification. One can easily focus research on chosen situations and devise tests which would probe the validity of previous findings.

Numerous ethnic and cultural groups can be found in our large cities, within the anthropologist's easy reach. The limitations of time and the exorbitant expenses characteristic of fieldwork would not apply to psychodramatic and other approaches to the study of such groups. The author of this discussion is at present engaged in just such a venture in the form of a research-project regarding the value-system and the personality of the Puerto-Ricans in the area of New York City.

## *CONFERENCES HELD*

### SECTION OF BIOLOGY

### "THE STATUS OF MULTIPLE SCLEROSIS"

APRIL 17 AND 18, 1953

The Section of Biology, with the cooperation of the National Multiple Sclerosis Society, held a conference on "The Status of Multiple Sclerosis." Doctor Pearce Bailey, Director, National Institute of Neurological Diseases and Blindness, National Institutes of Health, Bethesda, Maryland, was the Conference Chairman in charge of the meeting.

*Friday, April 17*

The program consisted of the following papers: *Morning Session.* Chairman: Harry M. Zimmerman.

Address of Welcome, Oliver E. Buckley, Vice-President, National Multiple Sclerosis Society, New York, N. Y.

"Quo Vadimus in Demyelinating Diseases," Seymour S. Kety, National Institute of Neurological Diseases and Blindness, National Institutes of Health, Bethesda, Md.

"Genetically Controlled Demyelination in the Mammalian Central Nervous System," Pinckney J. Harman, New York University College of Medicine, New York, N. Y.

"The Dynamics of Early Brain Disease with Particular Reference to Multiple Sclerosis," Berry Campbell, University of Minnesota Medical School, Minneapolis, Minn.

"Return of Spinal Cord Function in Mammals after Transecting Lesions," L. W. Freeman, Indiana University Medical Center, Indianapolis, Ind.

"Dermal and Serological Reactions to Nervous Tissue Antigens in the Demyelinating Diseases of Man," Byron H. Waksman and Ruth E. Stauffer, Massachusetts General Hospital, Boston, Mass.

"Electromyographic Patterns in Multiple Sclerosis," Joseph Moldaver, Demyelinating Disease Clinic, Hospital for Special Surgery, New York, N. Y.

"Circulatory Disturbances in Multiple Sclerosis," I. Mark Scheinker, Cornell University Medical College, New York, N. Y.

*Afternoon Session.* Chairman: Francis O. Schmitt.

"Metabolic Interrelationships in the Demyelinating Disorders," Richard C. Fowler, University of Rochester Medical Center, Rochester, N. Y.

"Amino Acid Chromatography in Cerebrospinal Fluids," Burnham S. Walker, Boston University School of Medicine, Boston, Mass.

"Genetically Controlled Demyelination in the Mammalian Central Nervous System," Pinckney J. Harman, New York University College of Medicine, New York, N. Y., and the Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine.

"Protein Fractions in Serum and Cerebrospinal Fluids in Multiple Sclerosis," Bruno W. Volk and Abraham Saifer, Jewish Sanitarium and Hospital for Chronic Diseases, Brooklyn, N. Y.

"Serological Reactions in Multiple Sclerosis," Joseph M. Foley, Boston University School of Medicine, Boston, Mass.

"Further Studies on the Gamma Globulin Content of Cerebrospinal Fluid in Multiple Sclerosis and Other Neurological Disorders," Melvin D. Yahr, Sidney S. Goldensohn and Elvin A. Kabat, Columbia Presbyterian Medical Center and College of Physicians and Surgeons, Columbia University, New York, N. Y.

*Saturday, April 18*

*Morning Session.* Chairman: Hans H. Reese.

"A Study of the Short and Long-Term Effects of Adrenal Steroids on the Clinical Patterns of Multiple Sclerosis," H. Houston Merritt, Gilbert H. Glaser, and Christian Herrmann, Jr., Columbia Presbyterian Medical Center, Columbia University, New York, N. Y., and Yale University School of Medicine, New Haven, Conn.

"Effects of Muscle Adenylic Acid in Multiple Sclerosis," Arthur Shapiro, Waldemar Medical Research Foundation, Brooklyn, N. Y.

"Ophthalmological Aspects of Multiple Sclerosis," C. Ray Franklin, Columbia Presbyterian Medical Center, Columbia University, New York, N. Y.

"Minnesota Test as a Guide to Therapy in Multiple Sclerosis," Harold A. Abramson, The Mount Sinai Hospital, New York, N. Y.

"Metabolic Characteristics of Multiple Sclerosis," Harold H. Jones, Howard H. Jones, Jr., Richard R. Howard, and Leitha D. Bunch, H. L. Snyder Memorial Research Foundation, Winfield, Kansas.

*Afternoon Session.* Chairman: Hans H. Reese.

"Diagnosis in Multiple Sclerosis and Related Diseases," George A. Schumacher, University of Vermont College of Medicine, Burlington, Vt.

"Predictability of Exacerbations and Remissions in Multiple Sclerosis," Leo Alexander and W. Paxton Parker, Boston State Hospital, Boston, Mass.

"Epidemiologic Factors in the Etiology and Prognosis of Multiple Sclerosis," Leonard T. Kurland and Knut B. Westlund, United States Public Health Service, Rochester, Minn., and National Institute of Mental Health, National Institutes of Health, Bethesda, Md.

"Total Rehabilitation in Multiple Sclerosis," Howard A. Rusk, Institute of Physical Medicine and Rehabilitation, New York University-Bellevue Medical Center, New York, N. Y.

"Specific Factors in Physical Rehabilitation for Multiple Sclerosis," George G. Deaver, New York University-Bellevue Medical Center, New York, N. Y.

"Observations on Pharmacological Agents Recently Suggested for Multiple Sclerosis," Morton Marks, New York University College of Medicine, New York, N. Y.

"Physiological Factors in Multiple Sclerosis," Molly Harrower, Children's Court, Court of Domestic Relations, New York, N. Y.

## BASIC ODOR RESEARCH CORRELATION

### April 23 and 24, 1953

The New York Academy of Sciences, in cooperation with the American Society of Heating and Ventilating Engineers, held a Conference on "Basic Odor Research Correlation." Thomas H. Urdahl, Chairman, Technical Advisory Committee on Odors, American Society of Heating and Ventilating Engineers, was the Conference Chairman in charge of the meeting.

The program consisted of the following papers:

*Thursday, April 23*

*Morning Session.* Chairman: A. B. Hubbard.

"Introductory Notes on Basic Odor Research Correlation," by the General Chairman, Albert R. Behnke, Captain (MC) U.S.N.

"Introductory Remarks," Thomas H. Urdahl, American Society of Heating and Ventilating Engineers.

"The Problem of Odor in the Cigarette Industry," F. R. Darkis, E. J. Hackney, W. W. Bates, and Lee Leiserson, Liggett and Myers, Inc., Durham, N. C.

"The Problems of Controlling Odors in Processing Protein Foods," Herman W. Dorn, Dorn and Company, Decatur, Ill.

"The Nature of the Odor Problem in the Paper Industry," Ernest Reed, Department of Plant Science, Syracuse University, Syracuse, N. Y.

"Odor Modifiers," Ernest Lawson, Fritzsche Bros., New York, N. Y.

"The Physiologist," Lloyd M. Biedler, Florida State College, Tallahassee, Fla.

"The Psychologist," Bernice Wenzel, Barnard College, Columbia University, New York, N. Y.

"The Physicist," Joseph Greenspan, Process and Instruments, Brooklyn, N. Y.

"The Chemist," James B. Sumner, Cornell University, Ithaca, N. Y.

"Odors, Odorants and Deodorants in Aviation," C. R. Spealman, Medical Division, Civil Aeronautics Administration, Washington, D. C.

"Hotel Odor Problems," Edward J. Kenney, Director of Laboratories, York Research Corporation, Stamford, Conn.

*Afternoon Session.* Session Chairman: Amos Turk.

"The Odorants," R. W. Moncrieff, Ayrshire, Scotland.

"Receptor Mechanism: The Olfactory Area and the Olfactory Receptor Process," Jean Mateson, Airkem, Inc., New York, N. Y.

"The Neural Apparatus Underlying Olfactory Perception," Carl Pfaffman and Maxwell M. Mozell, Brown University, Providence, R. I.

"Functions of the Olfactory Brain," Lawrence Kruger and Karl Pribram, Institute of Living, Hartford Conn., and Department of Physiology, Yale University, New Haven, Conn.

"The Physiology of Olfaction in Insects," V. G. Dethier, Johns Hopkins University, Baltimore, Md.

"An Information Theory of Olfaction," R. M. Hainer, A. G. Emslie, and Ada Jacobson, Arthur D. Little, Inc., Cambridge, Mass.

*Friday, April 24*

*Morning Session.* Session Chairman: Haldane Gee.

"The Validity of Practical Odor Measurement Methods," R. L. Kuehner, Research Engineer, York Corporation, York, Pa.

"Scheme for Odor Identification with Examples of Its Use," L. C. Cartwright and P. H. Kelley, Foster D. Snell, Inc.

"Odorous Atmospheric Gases and Vapors: Properties, Collection and Analysis," Amos Turk, Director of Research, Connor Engineering Corp., Danbury, Conn.

"Study and Evaluation of Odor Properties of Surfaces," Nicholas Deininger and Frederick Sullivan, Arthur D. Little, Inc., Cambridge, Mass.

"The Stability of Olfactory Sales," Lloyd Beck, L. Kruger, and Paul Calabresi, Yale University, New Haven, Conn.

"The Odor Problems in Federal Office Buildings," W. E. Reynolds, Commissioner, Public Buildings Service, General Services Administration, Washington, D. C.

*Afternoon Session.* Chairman: George W. Meek.

"Surface Phenomena Related to Odor Measurement," J. R. Eaton, J. E. Christian, and J. A. Campbell, Purdue University, Lafayette, Ind.

"Olfactory Nerve Potentials: A Direct Measure of Chemoreception in Insects," Chester Roys, Tufts College, Medford, Mass.

"Use of Odor in Experimental Neuroses with Monkeys," Jules Masserman and Curtis Pechtel, Northwestern University, Evanston, Ill.

"The Influence of Age on the Threshold of Olfactory Perception," I. Arthur Mirsky and Elsa Strauss, University of Pittsburgh, Pittsburgh, Pa.

These conferences are provided for active workers in the special fields represented. Attendance is limited to those invited to participate in these conferences and to interested Members of the Academy.

## *NEW MEMBERS*

*Elected April 23, 1953*

### SUSTAINING MEMBERSHIP

Fox, Sereck H., D. Sc., Nutrition, Pharmaceutical Control. Vice President, Pharmaceutical Research and Control, R. P. Scherer Corporation, Detroit, Mich.

Huffman, Max Niel, Ph.D., Chemistry. Professor of Research Biochemistry, University of Oklahoma, Oklahoma City, Okla.

Rose, Bram, M.D., Histamines, Immunology. Associate Professor of Medicine, McGill University, Associate Physician, Royal Victoria Hospital, Montreal, Canada.

Sherndal, A. E., Ph.D., D.Sc., Medicinal Chemistry. Vice President and Plant Manager, Winthrop-Stearns Inc., Rensselaer, N. Y.

Skinner, Frank Leslie, M.D., Medicine. Private Practice, Vancouver B. C.

### ACTIVE MEMBERSHIP

Adesman, Jerome, M.D., Medicine. Research Fellow, Sloan Kettering Inst., New York, N. Y.

Austin, James, A.M., Biochemistry, Chemistry. Director of Research, Jensen-Salsbery Laboratories, Kansas City, Mo.

Beidelman, Barkley, M.D., Medicine, Metabolism. Internist, The Medical Center, Pensacola, Fla.

Beizer, Lawrence H., M.D., Internal Medicine. Private Practice, Philadelphia, Pa.

Berenbaum, Arthur A., M. D. Cardiology. Instructor of Cardiology, University of Pennsylvania Hospital, Philadelphia, Pa.

Brav, Solomon S., M.D., Ophthalmology. Private Practice, Philadelphia, Pa.

Broadwin, Samuel, Philosophy, General Science. Executive, Royal Glass Works, Corp., Long Island City, L. I., N. Y.

Brown, Beverly J., B.S., Biochemistry. Research Assistant, Stanford University, San Francisco, Calif.

Carp, Leon M., M.D., Medicine, Private Practice, Philadelphia, Pa.

Chapple, Ronald V., M.D., Obstetrics, Gynecology. Director of Clinical Research, Ortho Research Foundation, Raritan, N. J.

Corn, Milton, B.S., Medicine. Medical Student, Yale University, New Haven, Conn.

Davenport, Leonard Stanley, B.S., Natural Science. Consultant in Science, Roslyn Public Schools, Roslyn, L. I., N. Y.

Del Nunzio, Richard F., M.D., Cardiology, Physiology. Private Practice, Brooklyn, N. Y.

Donin, Leon, Biological Chemistry, Pharmacology. Director of Scientific Research, Bruel & Company, Laboratories, Buenos Aires, Argentina.

Elliott, Henry W., Ph.D., Pharmacology. Lecturer and Assistant Research Pharmacologist, University of California Medical Center, San Francisco, Calif.

Fagerson, Irving, Ph.D., Food Chemistry, Technology. Assistant Research Professor, Department of Food Technology, University of Massachusetts, Amherst, Mass.

Fishman, Robert Allen, M.D., Neurology, Neurophysiology. Neurologist, Walter Reed Army Medical Center, Washington, D. C.

Frenkel, Jacob Karl, M.D., Experimental Pathology. Assistant Professor of Pathology, University of Kansas School of Medicine, Kansas City, Kansas.

Garreau, Roger, Ambassador of France, Delegate of the Republic of France to the United Nations, New York, N. Y.

Gillespie, Hazel B., Ph.D., Bacteriology. Associate Professor of Bacteriology, Rutgers University, New Jersey College for Women, New Brunswick, N. J.

Grunmeier, Paul W., Jr., M.S. Biology. Research Microbiologist, Wyeth Inst., Philadelphia, Pa.

Haddow, Alexander, D.Sc., Cancer Research. Director of the Chester Beatty Research Institute, Royal Cancer Hospital, London, England

Hewitt, Marshall Irving, M.D., Internal Medicine. Editorial Writer of Medical Literature, Parke Davis and Company, Detroit, Mich.

Horowitz, Lawrence, B.A., Medicine, Chemistry. Student, State University of New York, New York, N. Y.

Hosler, William W., D.Sc., Organic Chemistry. Vice President, Research and Laboratories, Strong Cobb and Company, Cleveland, Ohio.

Jambor, James John, M.D., Chemistry, Biology, Medicine. Resident Physician in Dermatology, University of Cincinnati, Cincinnati, Ohio.

Jaskoski, B. J., Ph.D., Parasitology. Assistant Professor of Biology, Creighton University, Omaha, Neb.

Joftes, David L., Ph.D., Physiology. Research Associate, University of Illinois, Chicago, Ill.

Karpman, Benjamin, M.D., Psychiatry. Chief Psychotherapist, St. Elizabeth's Hospital, Washington, D. C.

Lippman, Richard W., M.D., Medicine. Los Angeles, Calif.

Manuelidis, Elias Emanuel, M.D., Neuropathology. Instructor of Pathology and Preventive Medicine, Yale University, New Haven, Conn.

Marriott, Henry J. L., M.D., Internal Medicine. Assistant Professor of Medicine, University of Maryland, Baltimore, Md.

Martin, Constance, Ph.D., Physiology. Physiologist, Creedmoor Institute for Psychobiologic Studies, Queens Village, L. I., N. Y.

Mayfield, Frank H., M.D., Neurosurgery. Practicing Neurosurgeon, Cincinnati, Ohio.

Mellon, M. G., Ph.D., Analytical Chemistry. Professor of Analytical Chemistry, Purdue University, Lafayette, Ind.

Minatoya, Hiroaki, M.S., Physiology, Pharmacology. Research Associate in Pharmacology, Sterling-Winthrop Research Institute, Rensselaer, N. Y.

Munroe, W. G. C., M.D., Internal Medicine. Assistant Physician, Summit Park Sanatorium, Pomona, N. Y.

Patterson, James Fulton, M.D., Internal Medicine. Assistant Physician Senior Staff, New England Center Hospital, Boston, Mass.

Peachey, Clarence H., M.D., Medicine. Private Practice, Rochester, N. Y.

Rapaport, Ionel, M.D., Anthropology, Endocrinology. Physician, Professor, French School of Anthropology, Clichy (Seine), France.

Reichenberg, Stanley, B.S., Medicine, Biology. Medical Student, State University of New York, Brooklyn, N. Y.

Ross, Ira Franklin, D.D.S., Periodontia, Oral Pathology. Private Practice, East Orange, N. J.

Sah, Peter P. T., Ph.D., Organic Synthesis. Lecturer, Research Associate, University College of Pharmacy, San Francisco, Calif.

Sanders, Rosaltha, Ph.D., Biochemistry, Physiology. Senior Biochemist, The Creedmoor Institute for Psychobiologic Studies, Queens Village, L. I., N. Y.

Scheinker, Ilya Mark, M.D., Neurology, Neuropathology. Cornell Medical School, New York, N. Y.

Schier, W. Wilson, M.D., Internal Medicine. Assistant Chief Professional Services, Bronx V. A. Hospital, New York, N. Y.

Schwartz, Ferdinand F., M.D., Physical Medicine. Medical Director, Birmingham Institute of Physical Medicine and Rehabilitation, Birmingham, Ala.

Scott, Gordon Ramsay, B. S., Virology. Veterinary Research Officer, Kenya, East Africa.

Shaw, Frank R., Entomology. Associate Professor, Department of Entomology, University of Massachusetts, Amherst, Mass.

Silbert, Judith, B.A., Biology. Medical Technician, Queens General Hospital, Jamaica, L. I., N. Y.

Silvers, Willys K., B.A., Physiological Genetics. Graduate Student, Department of Zoology, University of Chicago, Chicago, Ill.

Sprague, B. Sheldon, B.A., M.Ch.E., Textile Physics. Section Head, Textile Evaluation Research, Celanese Corporation of America, Summit, N. J.

Stoppani, A. O. M., M.D., Ph.D., Biochemistry. Hon. Assistant of Research, National Institute for Medical Research, London, England.

Strode, Jack W., M.D., Medicine. Army Medical Corps., New York, N. Y.

Talbott, Edmund J., M.D., Parasitic and Tropical Diseases. Physician, Research Laboratory of Tropical Diseases, National Institutes of Health, Bethesda, Md.

Therman, Per-Olof G., M.D., Neurophysiology, Neuropsychiatry. Assistant Professor of Neurophysiology in Psychiatry, University of Pennsylvania, Philadelphia, Pa.

Upton, Elizabeth, M.S., Bacteriology. Research Assistant, University of Wisconsin, Madison, Wis.

Usdin, Earl, Ph.D., Organic Chemistry. Research Associate, Institute for Cancer Research, Philadelphia, Pa.

Verlot, Max G., M.D., Neurophysiology. Private Practice, Rego Park, L. I., N. Y.

Walder, Kurt, M.D., Orthopedic Surgery. Hospital for Joint Diseases, New York, N. Y.

Warner, Allan H., M.D., Medicine. Visiting Physician, Willard Parker Hospital, New York, N. Y.

Weill, Andrew, M.D., Medicine, Surgery. Private Practice, Woodside, L. I., N. Y.

Weinberger, Walter P., B.S., Chemistry. Director of Chemical Section, Paglo Laboratories, New York, N. Y.

West, Margaret King, A.B., Mycology, Bacteriology. Research Associate, Department of Bacteriology, Sharp & Dohme, Inc., West Point, Pa.

Williams, Martin W., B.A., Endocrinology. Assistant, Ohio State University, Columbus, Ohio.

Wugmeister, Leon, M.D., Endocrinology. Private Practice, Long Island City, N. Y.

Zane, Manuel D., M.D., Psycho-analysis. Private Practice, New York, N. Y.

Zinker, Leonard L., M.D., Neurology. Senior Resident in Neurosurgery, Veterans Hospital, Bronx, New York, N. Y.

## STUDENT MEMBERSHIP

Day, Ronald, Student, Chatham, N. J.

Owooh, Francis B., B.Sc., Ethnology, Anthropology. Student, Columbia University, New York, N. Y.